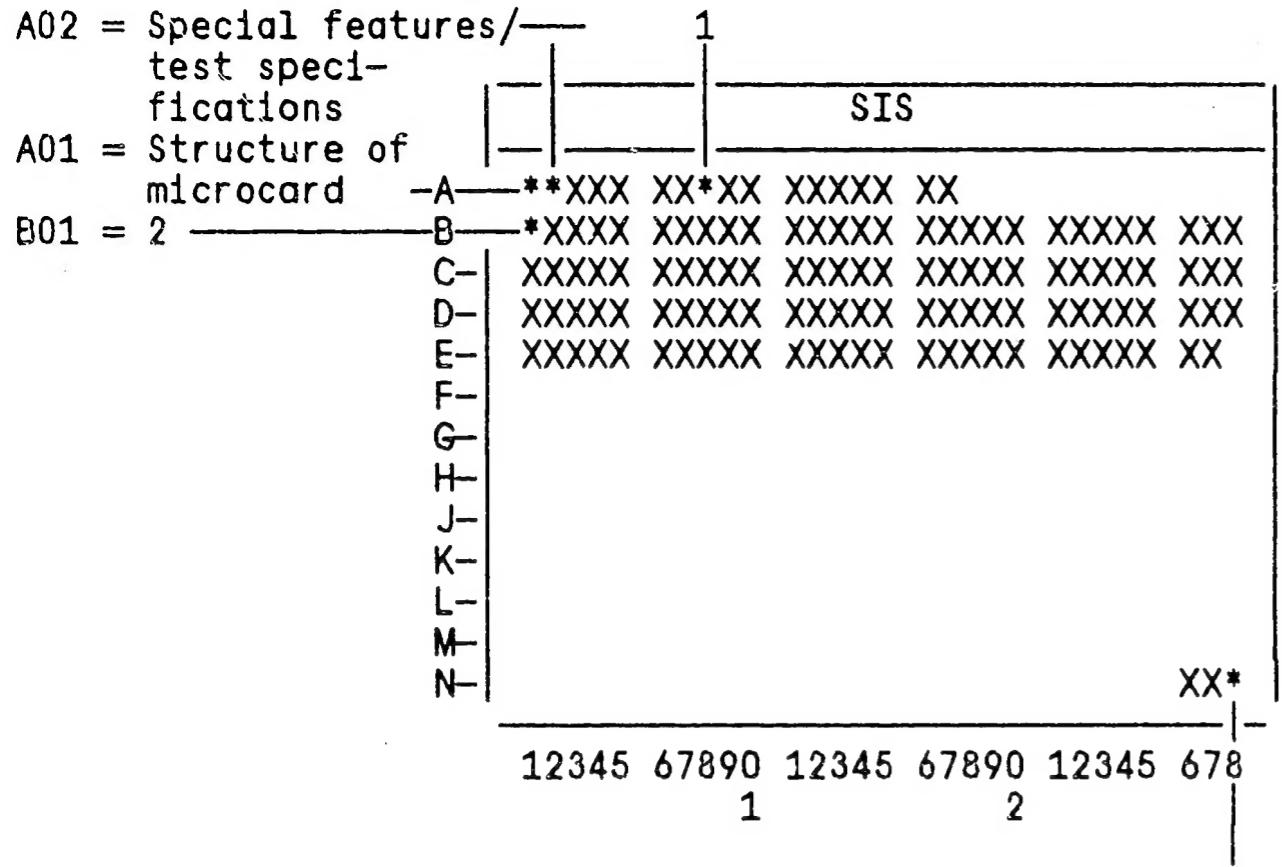


STRUCTURE OF THE MICROCARD



N28 = Table of contents and publication information

- 1 = Tools and devices
- 2 = Complete instructions, divided into test steps (no references)

- a. Read from left to right.
- b. Title of micropicture (appears on each coordinate).

E16	Product/component/test step	
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Coordinate

c. Limits of section



A01	—	=> <=
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* SPECIAL FEATURES

This microcard contains repair instructions for the KE starting motors 0 001 420 .. and 0 001 421 ..

ELECTRICAL TEST SPECIFICATIONS

Coil resistances

Holding winding		Pull-in winding
24 V	: 3,28...3,62 Ω	0,513...0,567 Ω
12 V	: 0,712...0,788 Ω	0,152...0,168 Ω

Solenoid-switch test specifications

Minimum voltage for solenoid switch with tooth/tooth connection

- 24 V solenoid switch : ≤ 16,0 V
- 12 V solenoid switch : ≤ 8,0 V

Starting-motor test specifications

Idle values	V	A	min ⁻¹	Torque
0 001 420 ...	24	< 140	> 5500	
0 001 421 ...	11,5	< 200	> 5500	

Short-circuit values

0 001 420 ... (with 2 batteries 12V143Ah connected in series)	9	< 1400	> 110 Nm
0 001 421 ... (with 2 batteries 12V143Ah connected in parallel)	4,0 4,5	< 1900 < 2050	> 75 Nm > 90 Nm

A02	—	=> <=
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MECHANICAL TEST SPECIFICATIONS

Commutator diameter when new : 50 mm
 Minimum commutator diameter : 48 mm

Brush pressure (per brush spring) : 47...53 N
 Minimum carbon-brush length : 17,5 mm

Axial armature play
 Commutator end shield w i t h
 n o screw plug : 0,1...0,4 mm

Axial armature play
 Commutator end shield w i t h
 screw plug : 0,1...0,3 mm

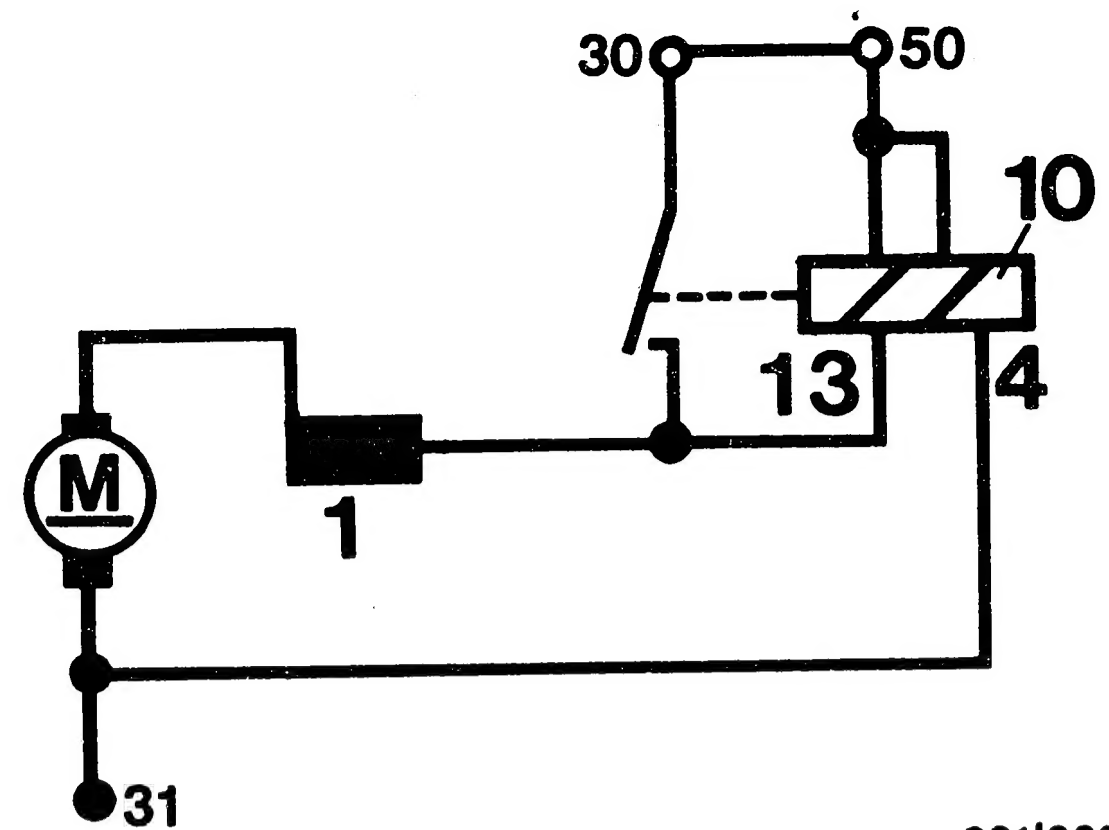
Backlash : 0,6...0,9 mm

Eccentricity

Commutator : 0,03 mm

Laminated core : 0,08 mm

Spacing A
 (Mounting bracket - solenoid
 switch/solenoid-switch dome) : 62,5+0,2...0,5 mm



001/090

- 1 = Series winding (excitation winding)
- 4 = Holding winding
- 10 = Solenoid switch
- 13 = Pull-in winding

DIAGRAM FOR STARTING MOTORS 0 001 420 ..; 0 001 421 ..

GENERAL INFORMATION

In order to guarantee perfect operation, the lubricants specified in these instructions must be used.

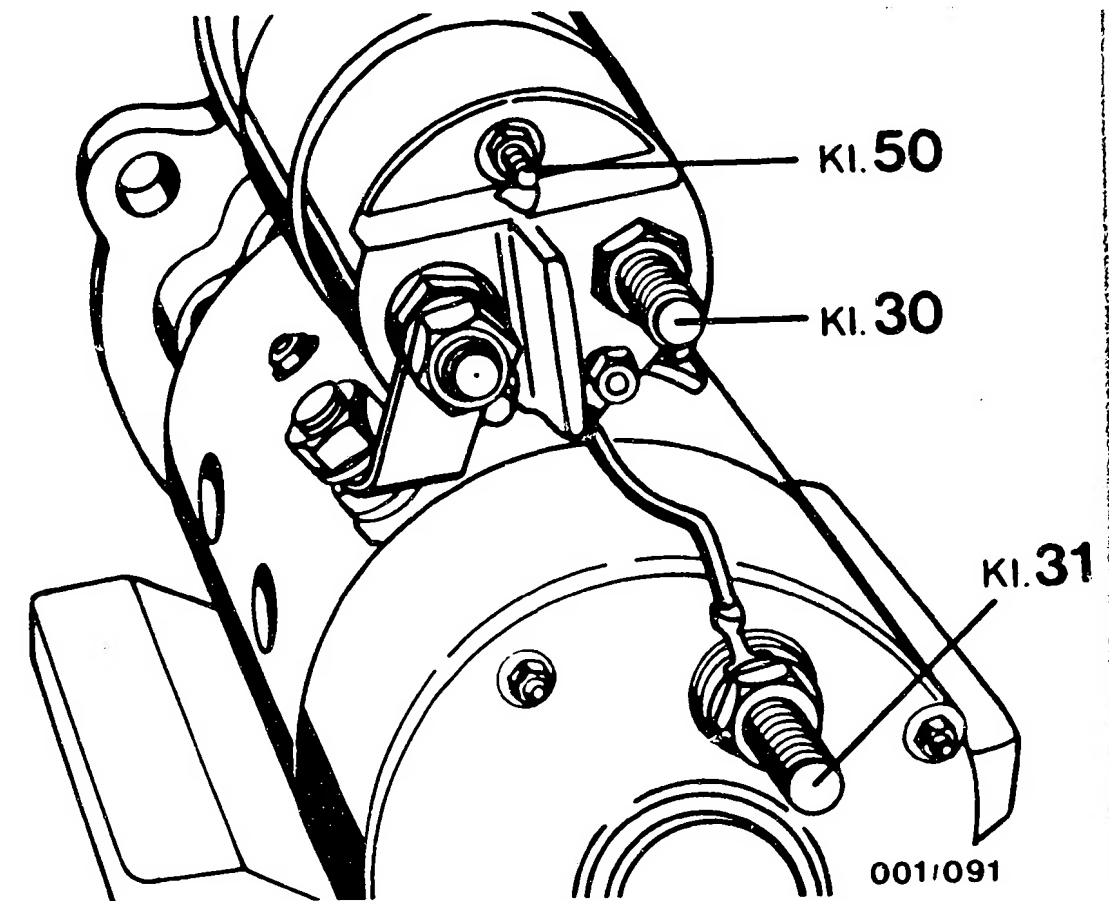
Professional repairs are only possible using the specified tools and measuring instruments. We therefore advise you to use only the tools listed.

Never reuse any gaskets and seal rings or the micro-encapsulated bolt at the fork lever.

The needle bushings in the drive-end-bearing housing and in the intermediate bearing must likewise be replaced.

The bolts secured with Loctite must be secured again with Loctite 5 965 930 512 before reassembly.

Slightly grease all O-rings before reassembly with special lubricating grease 5 932 240 150.



The starting motors 0 001 420 ...
0 001 421 ...
are insulated with respect to negative (ground).

Cleaning the parts

Clean armature, winding, overrunning-clutch drive and solenoid switch only with compressed air (max. 4 bar) and a clean rag. Do not use liquid cleaning agent.

Other parts, such as screws and armature shaft can be washed in commercially available cleaning agent of low inflammability. Do not inhale vapors!

C A U T I O N

Parts which have been washed must be dried thoroughly since, otherwise, gases may form in the starting motor when it is later sealed - danger of explosion.

Observe local safety regulations!

TESTERS AND TOOLS REQUIRED

Testers:

Test bench for starting motors	EFAL 152 EFAL 153 EFAL 140
only in conjunction with clamping flange	KDAL 5046
Test panel	KDAW 9984
Transformer panel	KDAW 9985
Interturn-short-circuit tester (previously FAW95)	KDAW 9978
Electric Tester or resistance measuring bridge	0 684 101 400 commercially available

Tools:

Holding tool for armature shaft	KDAL 5036
Measuring tool with dial-indicator insert	KDAL 5037
Press-out mandrel (for commutator end shield with screw plug)	KDAL 5038
Press-out and press-in mandrel	KDAL 5039
Press-in mandrel (intermediate bearing)	KDAL 5040
Press-in mandrel (for seal ring in intermediate bearing)	KDAL 5041
Clamping fix. (solenoid switch)	KDAL 5042
Cap with 2 test connections and seal (for leak test)	KDAL 5043

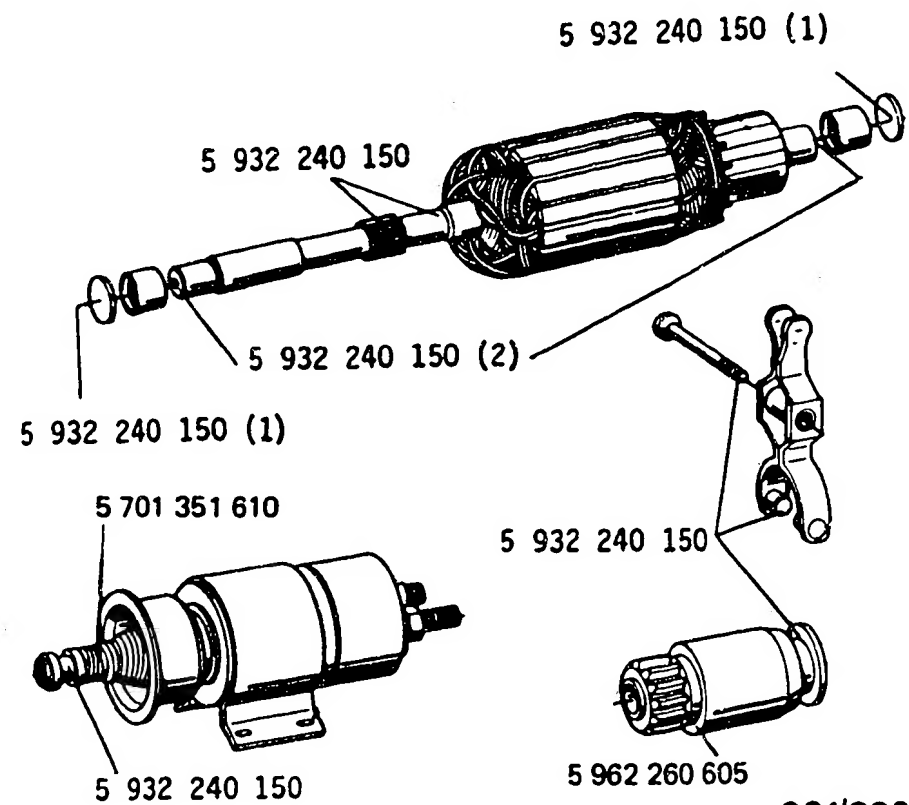
TOOLS REQUIRED (continued)

Drive-in mandrel	KDAL 5044
Bushing	KDAL 5045
Puller	KDAL 5492
For the above, collet and threaded pin	KDAL 5492/1
Clamping pin in mandrel press	KDLI 6010
Tailstock backrests for supporting armature when turning down commutator	
with Morse taper 2	KDAW 9987
with Morse taper 3	KDAW 9990
Spring scale	
Measuring range 15 ... 50 N	KDAW 9992
or	
Measuring range 0 ... 100 N	commercially available
Undercutting saw	KDAW 9998
Clamping support	KDAW 9999
Dial indicator	1 687 233 011
Magnetic instrument stand	4 851 601 124
or	
Magnetic instrument stand	commercially available
Torque wrench	commercially available
Mandrel press	commercially available

LUBRICANTS

Special lubricating grease for plain and rolling bearings, pinion, washers, shafts and radial-lip-type oil seals.

500 g can (VS 10832 Ft)	5 932 240 150
Anti-corrosion oil	
1,0 l can (Ol 41 v 2)	5 701 351 610
Grease for relay armature	
50 g tube (VS 16 634 Ft)	5 990 260 005
Loctite for securing the relay screws	
50 g PVC bottle (VS 14201 Kk)	5 965 930 512
Loctite for sealing off	
50 g PVC bottle (VS 14618 Kk)	5 970 100 512



001/092

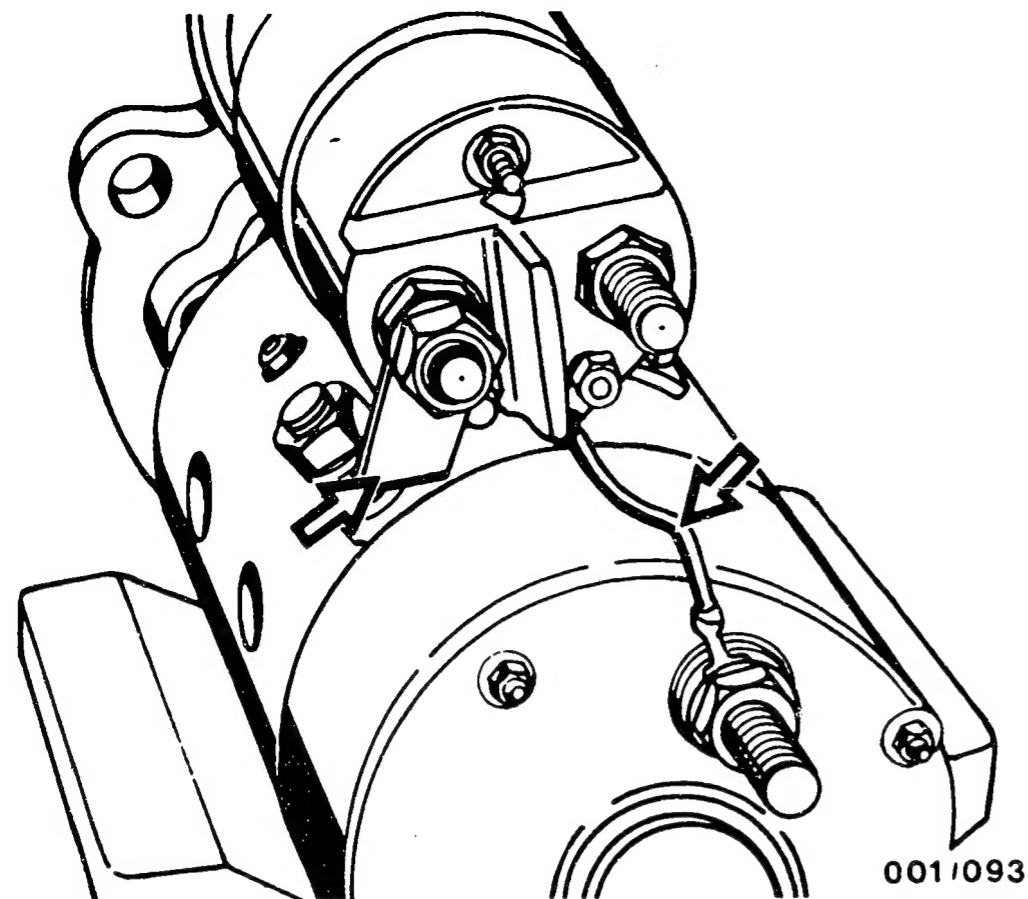
LUBRICATION CHART

The commutator must be kept free of grease and oil!

The indicated parts are to be sparingly greased and/or oiled. Too much grease would cause malfunctions at low temperatures.

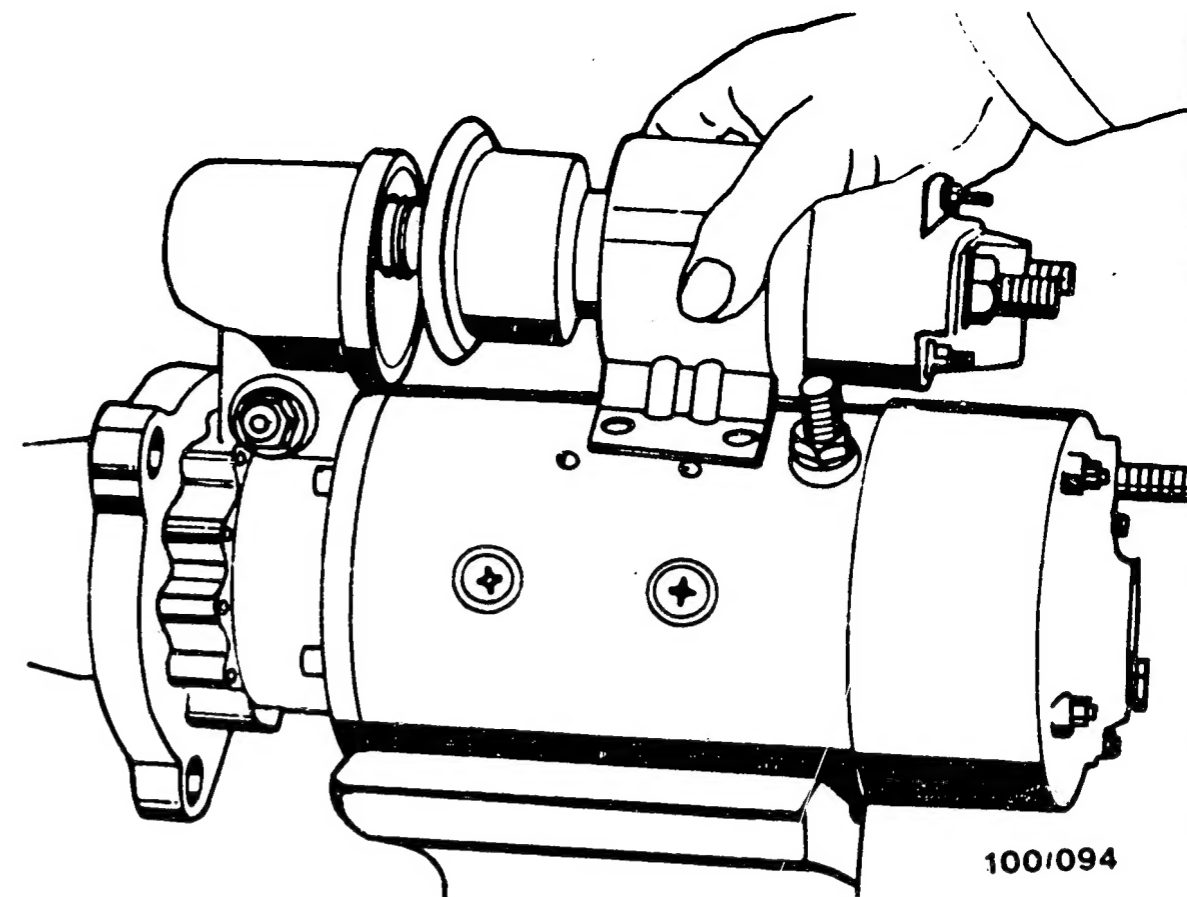
All other bright parts are to be lubricated with a small quantity of anti-corrosion oil.

For production reasons:
continued on the following
coordinate.



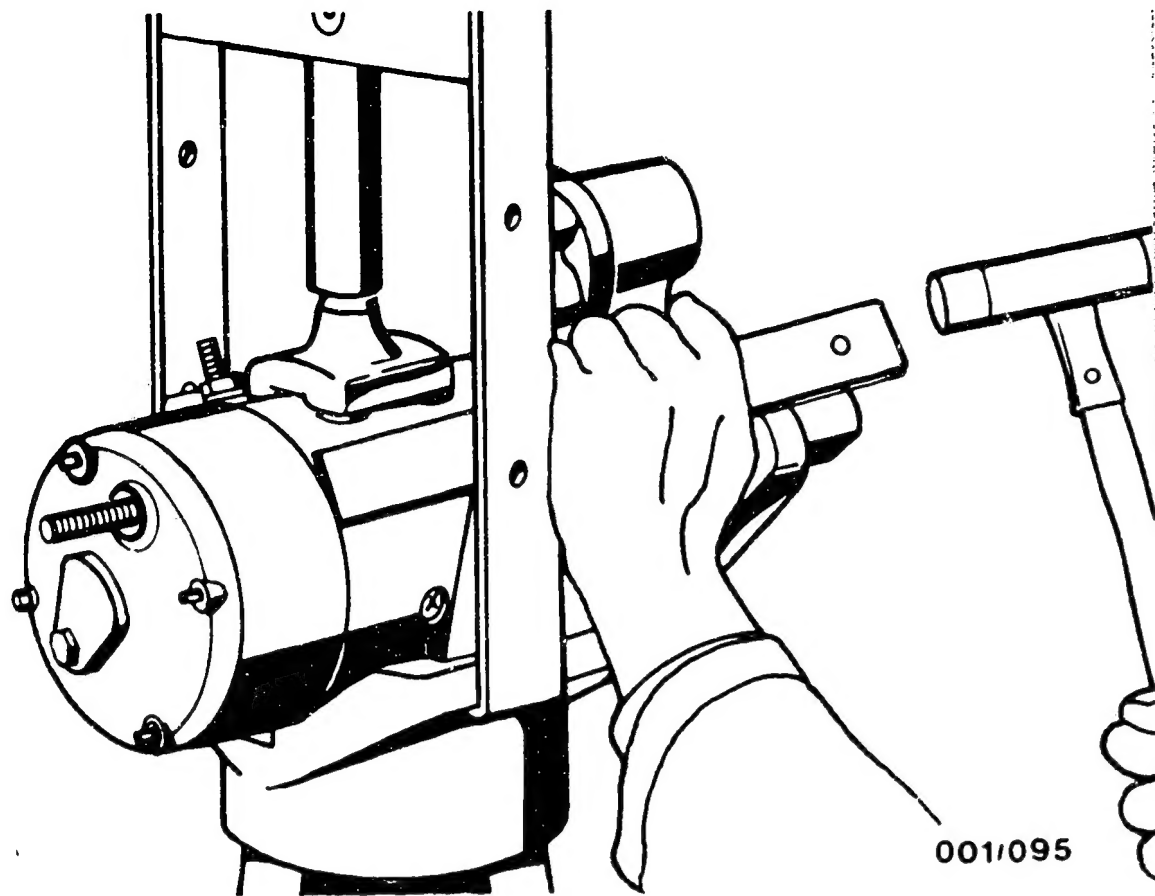
DISASSEMBLY OF STARTING MOTOR

Place starting motor in clamping support KDAW 9999.
Remove bus bar and lead (arrows).



Remove solenoid switch

Unscrew solenoid switch from stator frame,
raise it slightly and in doing so disengage
it from fork lever.



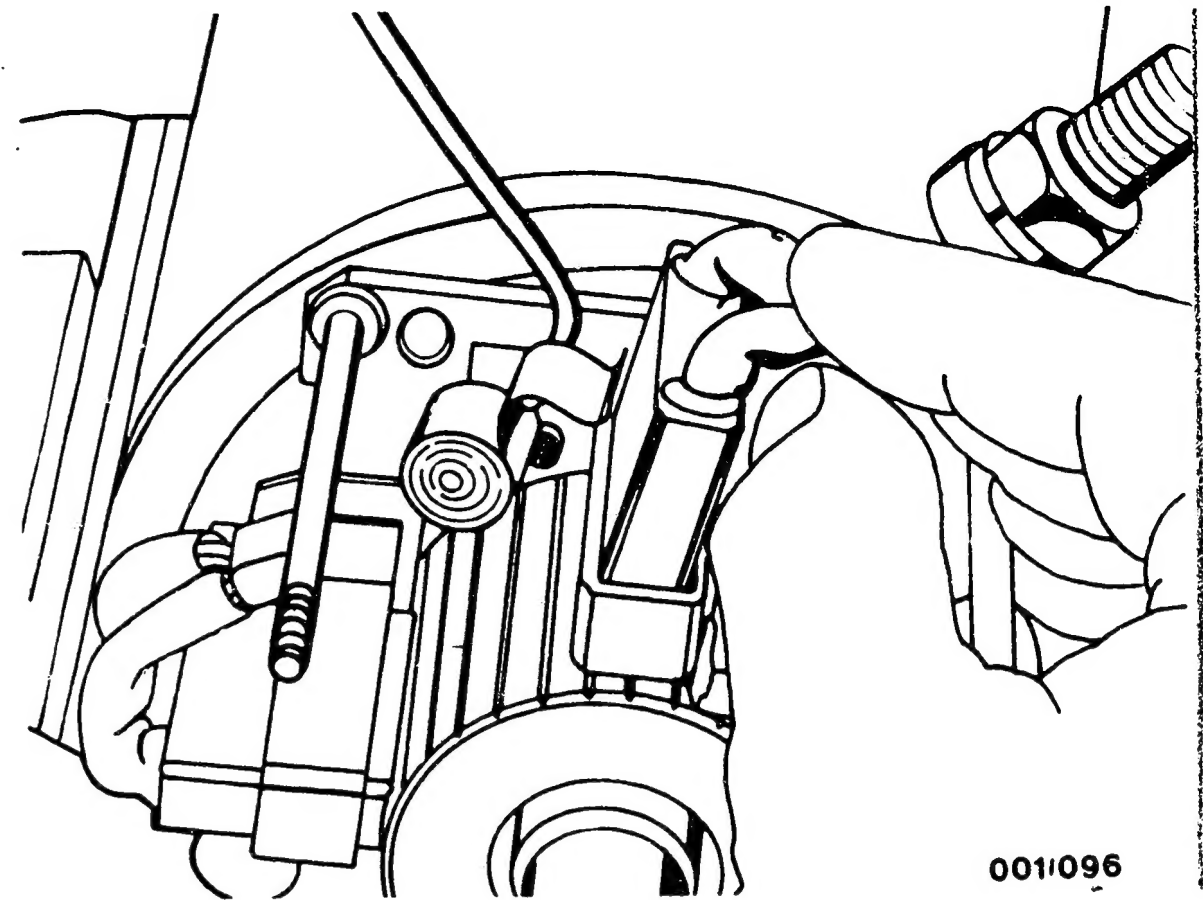
Remove commutator end shield

Loosen fastening nuts at commutator end shield.

Pay attention to gasket.

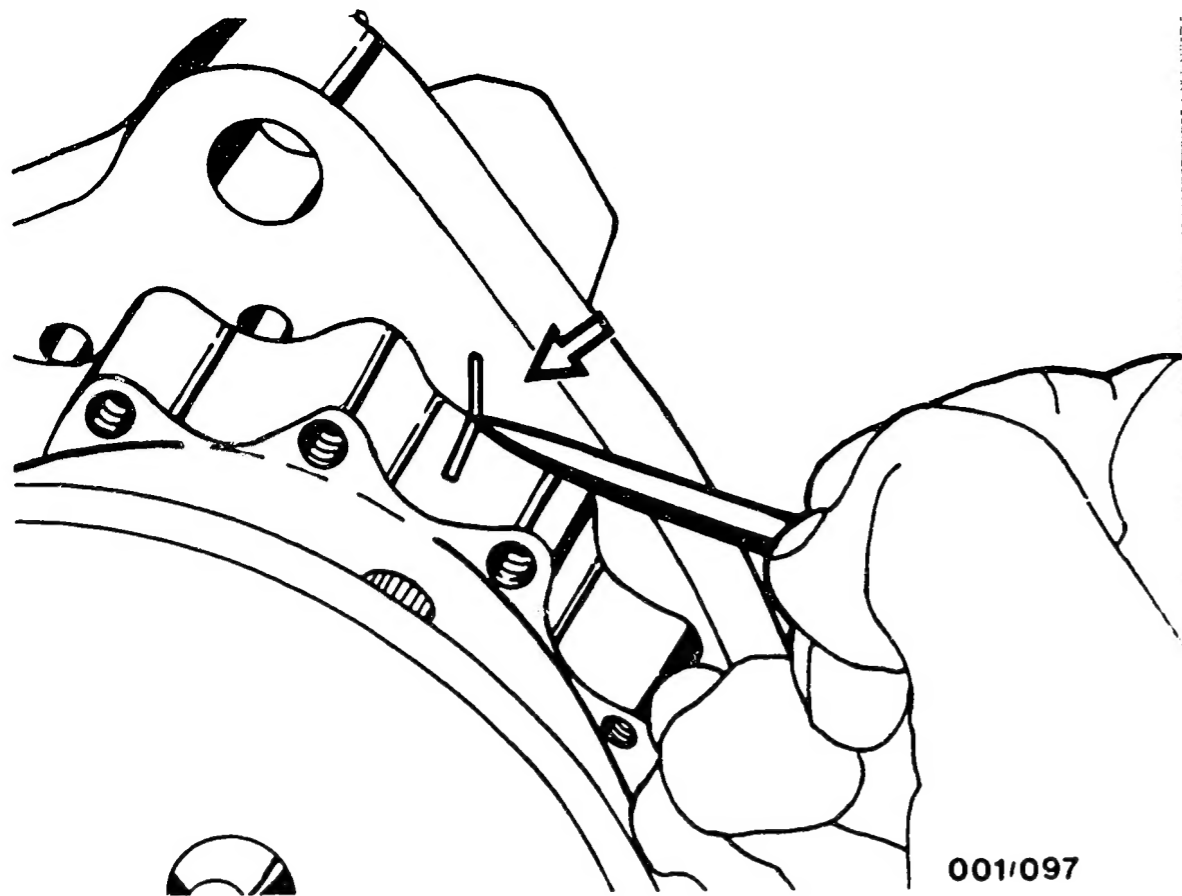
If applicable, unscrew screw plug for adjustment of axial armature play.

Use aluminum or copper bar to carefully and gently remove commutator end shield (see picture).



Remove carbon brushes

Use suitable wire hook to raise brush springs and pull out carbon brushes.



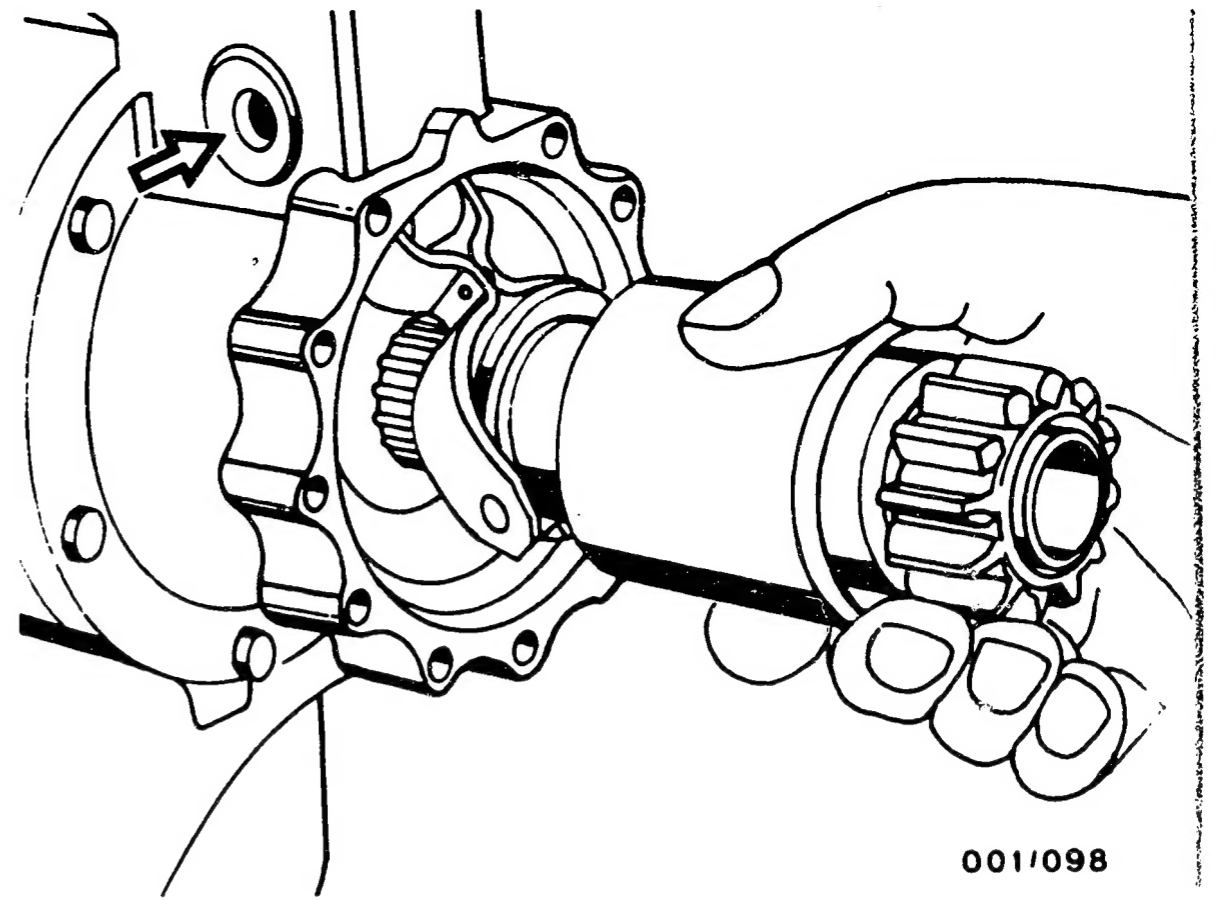
001/097

Remove drive-end-bearing housing:

Mark position of drive-end-bearing housing/intermediate bearing (see picture, arrow).

Loosen fastening screws of drive-end-bearing housing.

Use aluminum or copper bar to carefully and gently remove drive-end-bearing housing from intermediate bearing.

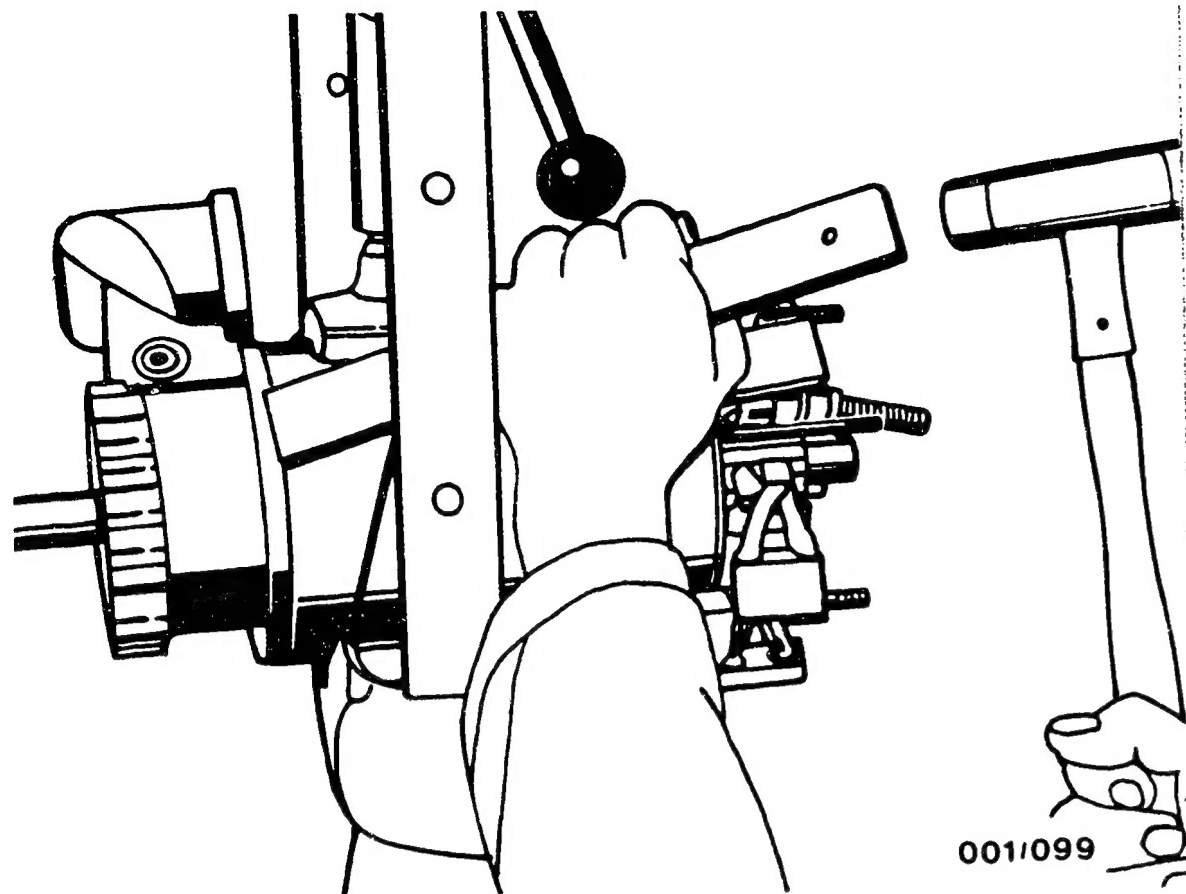


001/098

Remove overrunning-clutch drive

Remove flat-head screw from fork-lever mount (picture, arrow).

Remove friction washer (steel), overrunning-clutch drive with fork lever and plastic friction washer (intermediate bearing) from armature shaft.



Remove intermediate bearing

Loosen fastening screws of intermediate bearing.

Use aluminum or copper bar to gently detach intermediate bearing from pilot of stator frame (see picture).

Remove armature from stator frame.

Cleaning the parts

Clean armature, winding, overrunning-clutch drive and solenoid switch only with compressed air (max. 4 bar) and a clean rag. Do not use liquid cleaning agent.

Other parts, such as screws and armature shaft can be washed in commercially available cleaning agent of low inflammability. Do not inhale vapors!

CAUTION

Parts which have been washed must be dried thoroughly since, otherwise, gases may form in the starting motor when it is later sealed - danger of explosion.

Observe local safety regulations!

Working with dangerously inflammable or health-hazardous agents

Benzine, tri- or perchloroethylene are approved for the washing of motor vehicle electrical parts which are to be repaired. Both cleaning agents must be used cautiously since they are dangerous.

Benzin, acetone or ethanol are combustible liquids and can explode when mixed with air. Washing must be performed only in specially designed bowls or containers with a fused lid so that if the liquid ignites, the lid closes automatically and smothers the fire. Larger washing containers (as of 500 x 500 mm) must be provided with an extractor.

On the subject of starting motors, it has already been pointed out in earlier repair manuals that after the parts have been washed, particularly after windings have been washed in benzine, they must be dried thoroughly.

Tri- and perchloroethylene are liquids whose vapors have an anesthetic effect and are hazardous to health if inhaled over long periods of time. Trichloroethylene vapors are heavier than air and, therefore, the risk is greater near ground level. Protective goggles and gloves must be worn when washing.

Regular or continuous cleaning with trichloroethylene must take place only in specially designed containers with the extractor switched on. When washing, avoid leaning over the trichloroethylene container.

EXAMINATION AND REPAIR

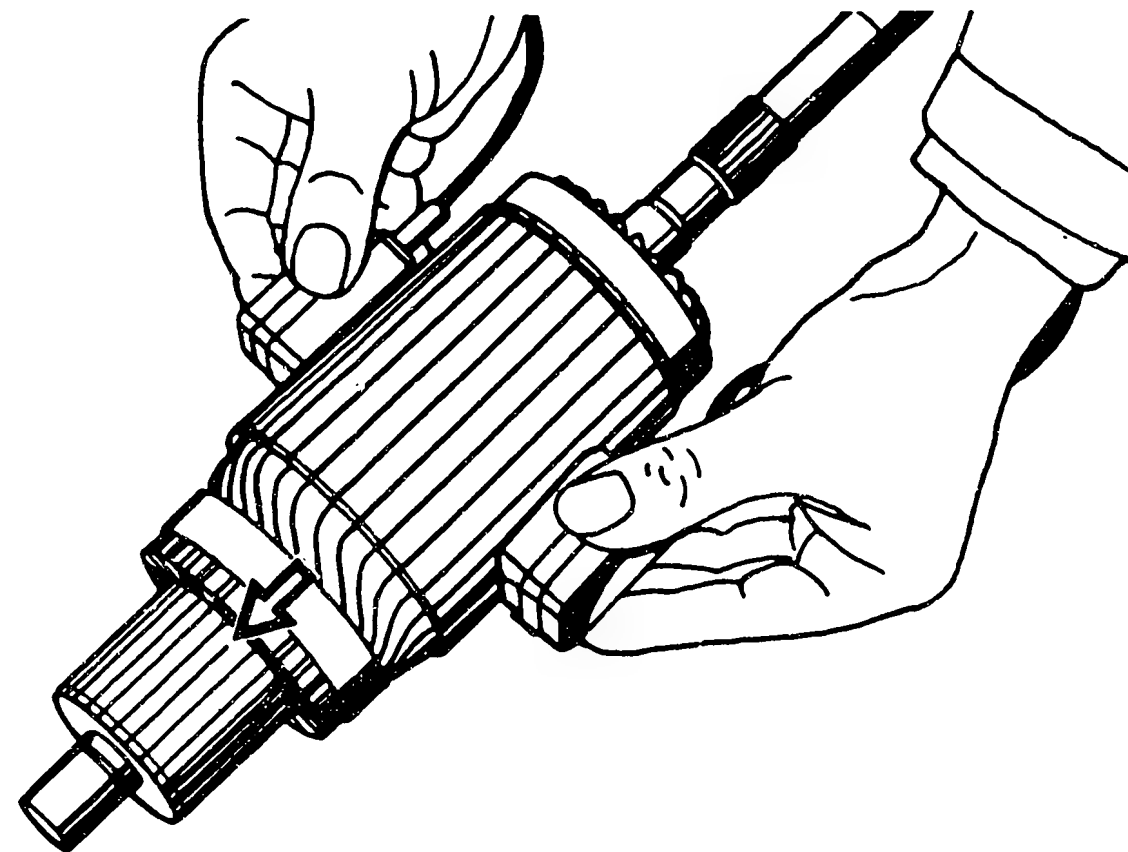
General

All parts are to be examined for wear and damage. Worn/damaged parts are to be replaced.

Micro-encapsulated screws/seals which have already been used may not be re-used.

Lubricate starting motor in accordance with lubrication chart prior to and during assembly. If necessary, lubrication points and lubricants are indicated in the text.

A complete lubrication chart is also available on Coordinate A11.



001/100

Test armature

Use tester KDAL 9978 to test armature for interturn short-circuit (see picture).

Use tester KDAW 9984 and 9985 or KDAW 9978 to test for short-circuit to ground.

Test voltage (A.C. voltage):

30 V for 24 V starting motors

40 V for 12 V starting motors

Pay attention to possible open-circuits (individual laminations are black - arrow).

Turn down and saw out commutator

The commutator of the armature can be turned down if necessary (if wear is visible). The minimum commutator diameter must however be maintained.

Scorch marks are an indication of an open-circuit in the armature windings - the armature must then be replaced.

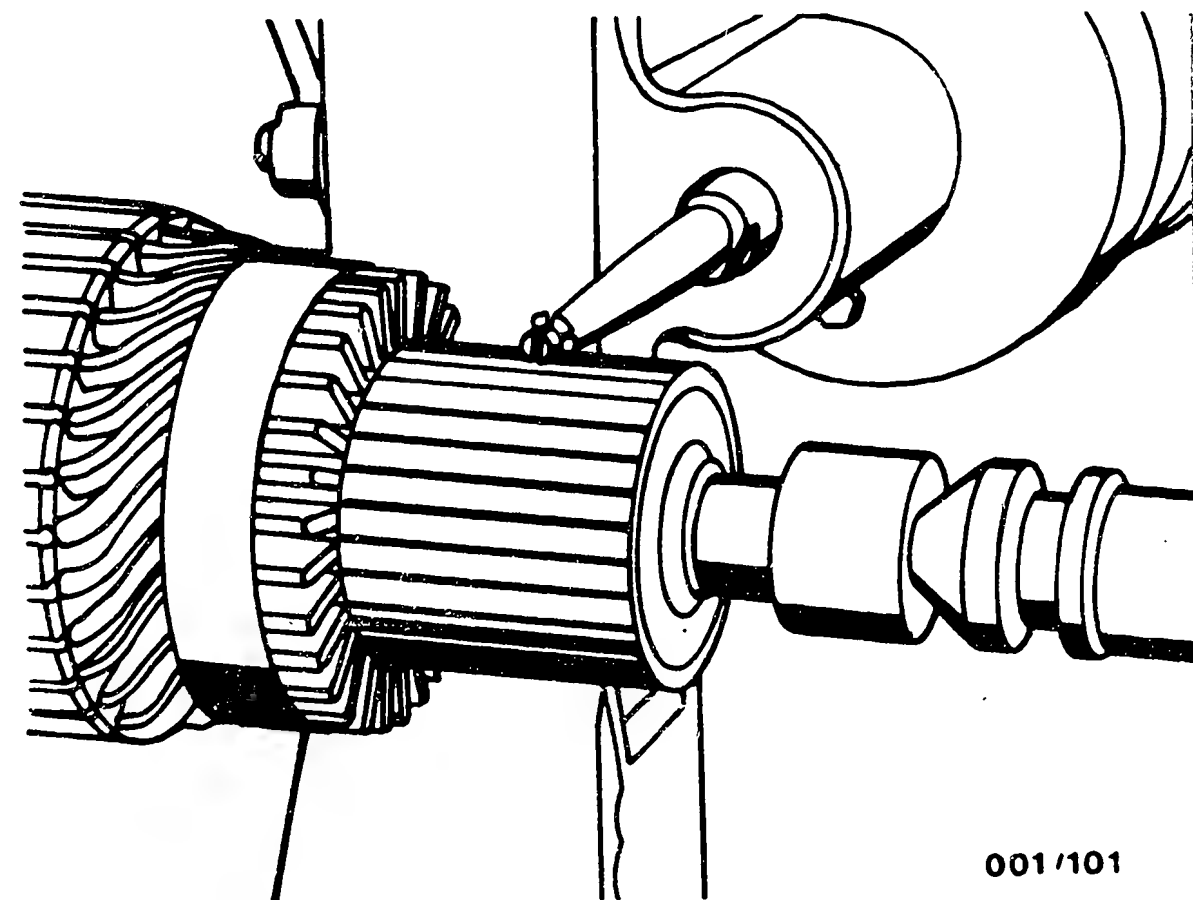
Clamp armature at commutator and drive-end-bearing housing ends. Take care not to damage armature shaft.

Pre-turning:

We recommend the use of a carbide cutting tool.

Turn down commutator until wear is no longer visible.

Minimum commutator diameter: 48 mm.



001/101

Undercutting and finish-turning the commutator

Clamp commutator in the clamp of the undercutting saw KDAW 9998. Undercut insulation between the laminations to a depth of 0.8 mm.

Note:

The insulation between the commutator laminations contains asbestos; the dust given off must under all circumstances be extracted.

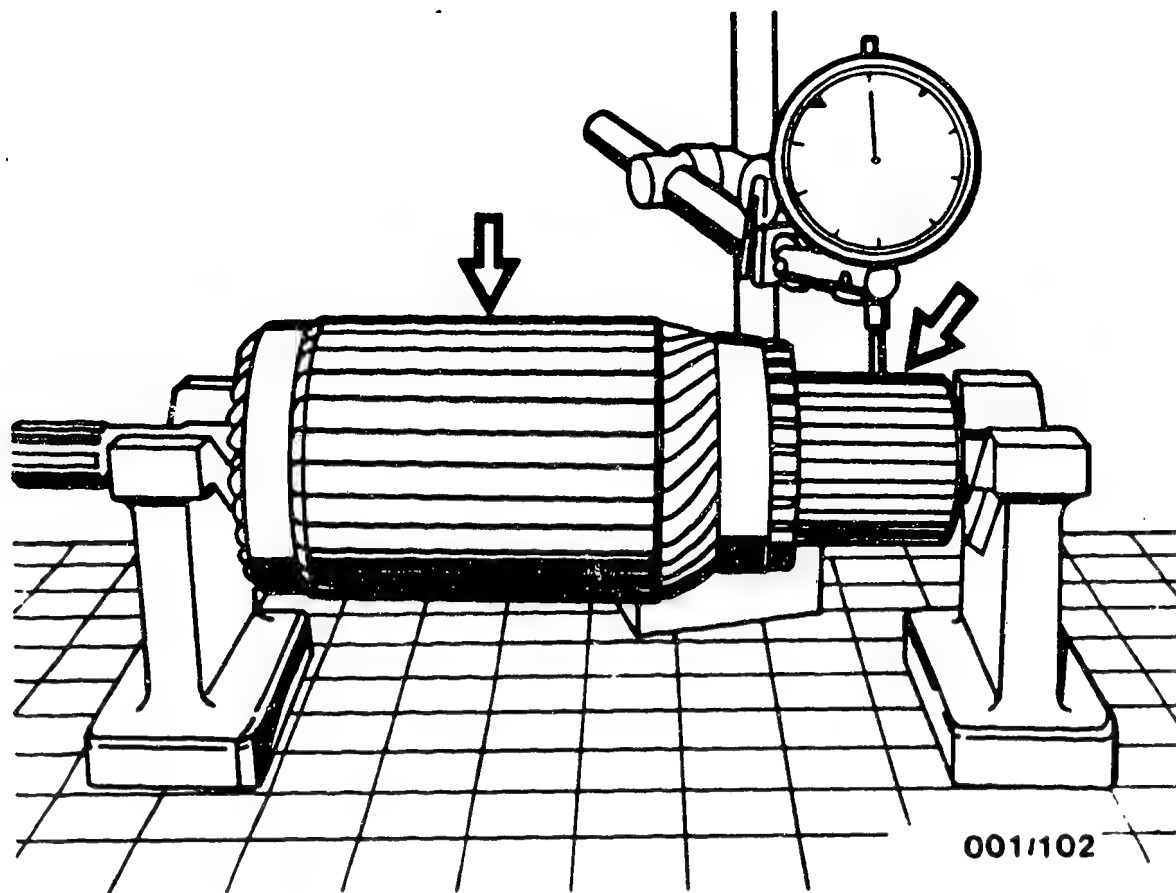
HEALTH HAZARD!

Finish-turning:

Clamp commutator in lathe again and skim with fine turning tool.

Turning chips may be max. 0.03 mm thick.

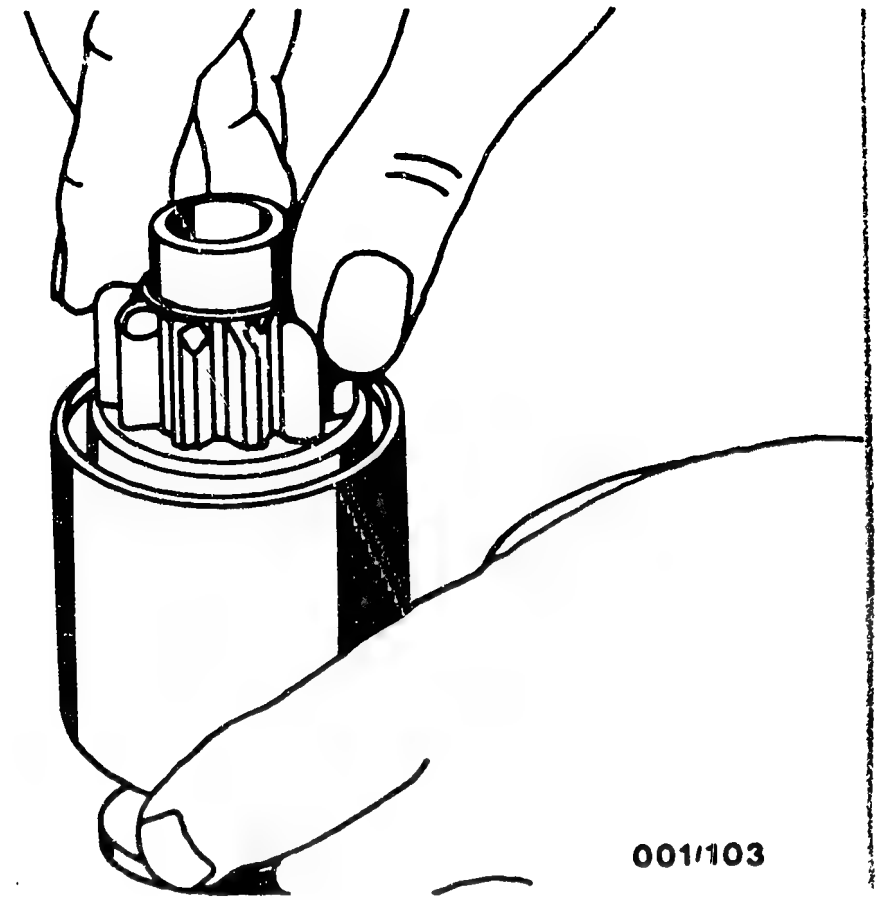
After finish-turning, brush out the commutator using a clean thread-cleaning brush free from oil and grease.



Testing true running of the armature:

Commutator ≤ 0.03 mm
 Laminated core ≤ 0.08 mm

Check the winding bindings for damage.



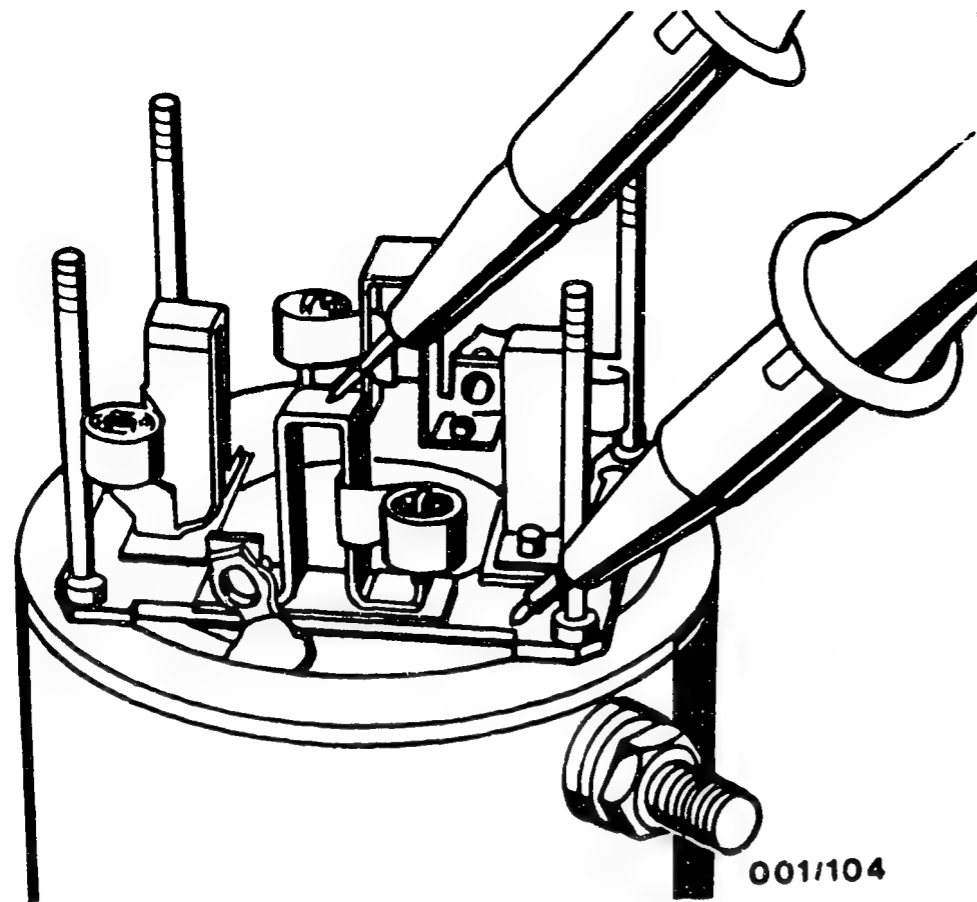
Testing the overrunning-clutch drive

Visual examination:

Surfaces must be free of damage – pay particular attention to the pinion!

Functional test:

- Hold the housing rigid and turn the pinion in the direction of drive. The clutch tothing must indicate operation of the overrunning clutch by making an audible rattle noise.
- Hold the housing rigid and turn the pinion in the opposite direction – frictional connection.
- Hold the housing rigid and press the pinion into the housing as far as it will go. The pinion must be able to be pushed in by at least 10 mm (see illustration).
 On being released, the pinion must spin back again to its initial position.



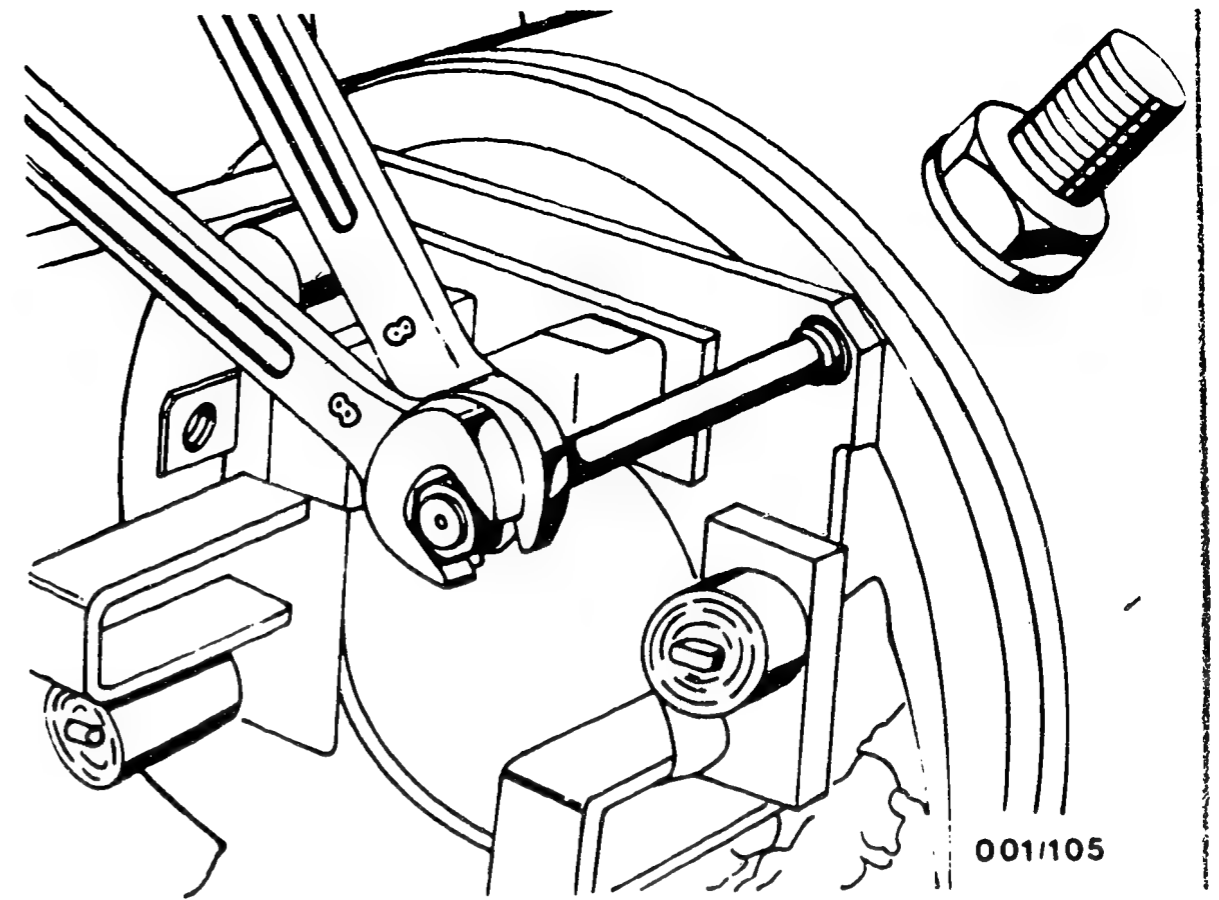
Test brush holder

Unscrew carbon brushes and leads.

Test insulated brush holders for short-circuit to ground.

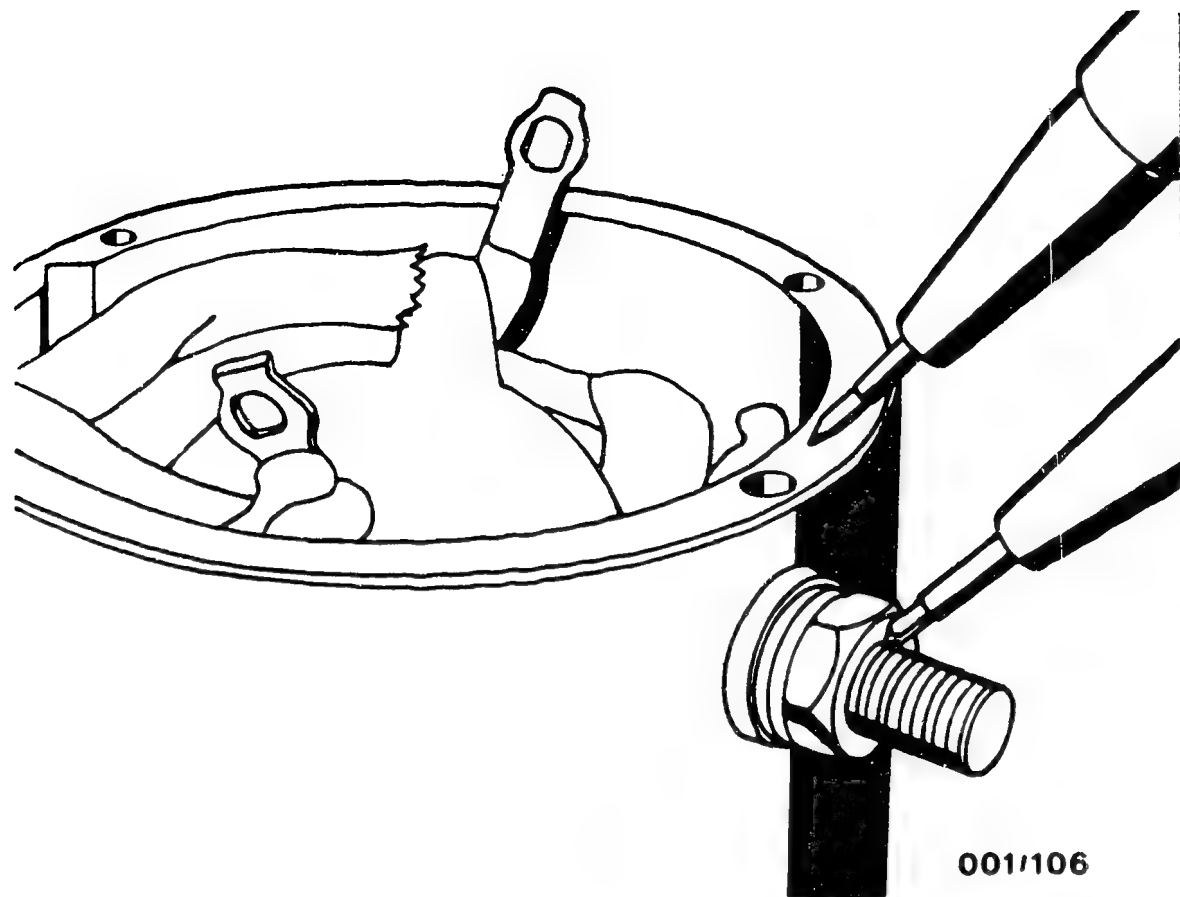
Tester KDAW 9978 or KDAW 9984 and KDAW 9985, test voltage 80 V (A.C. voltage).

Check spiral springs for carbon brushes. Renew damaged or burned-out spiral springs.



Remove brush holder

Loosen threaded pin of brush holder by way of two locked nuts.

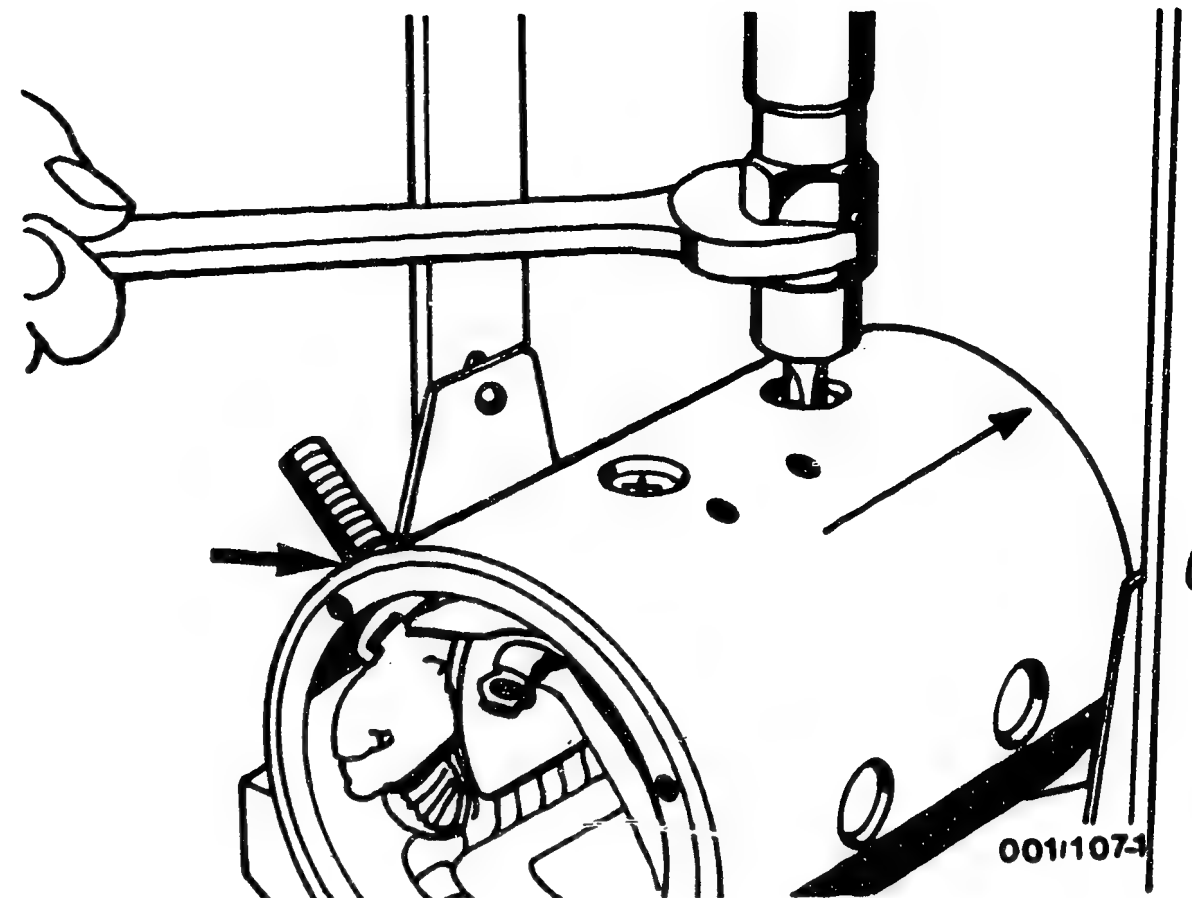


001/106

Test stator frame with excitation winding

Use tester KDAW 9984 and KDAW 9985 to test excitation winding for open-circuit. Test voltage: 6 V DC.

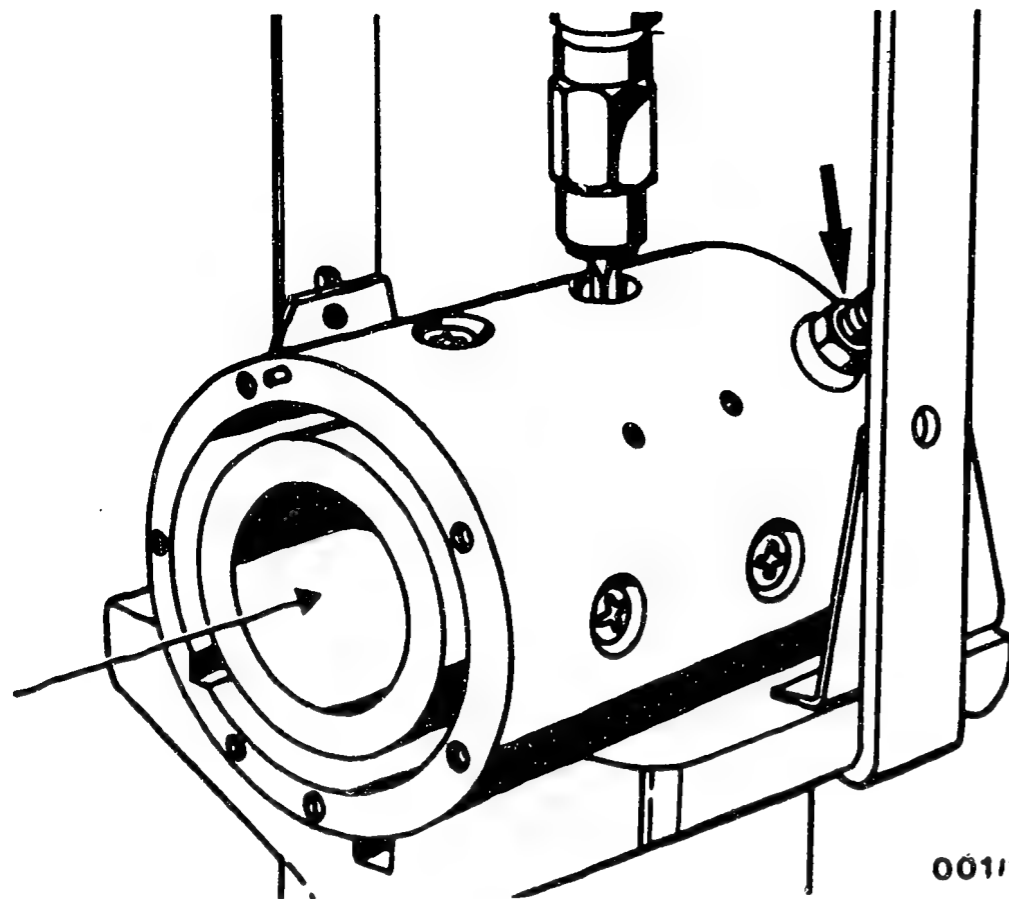
Perform short-circuit to ground test (see picture).
 Test voltage (A.C. voltage):
 80 V for 24 V starting motors
 40 V for 12 V starting motors.



001/107

Remove excitation winding

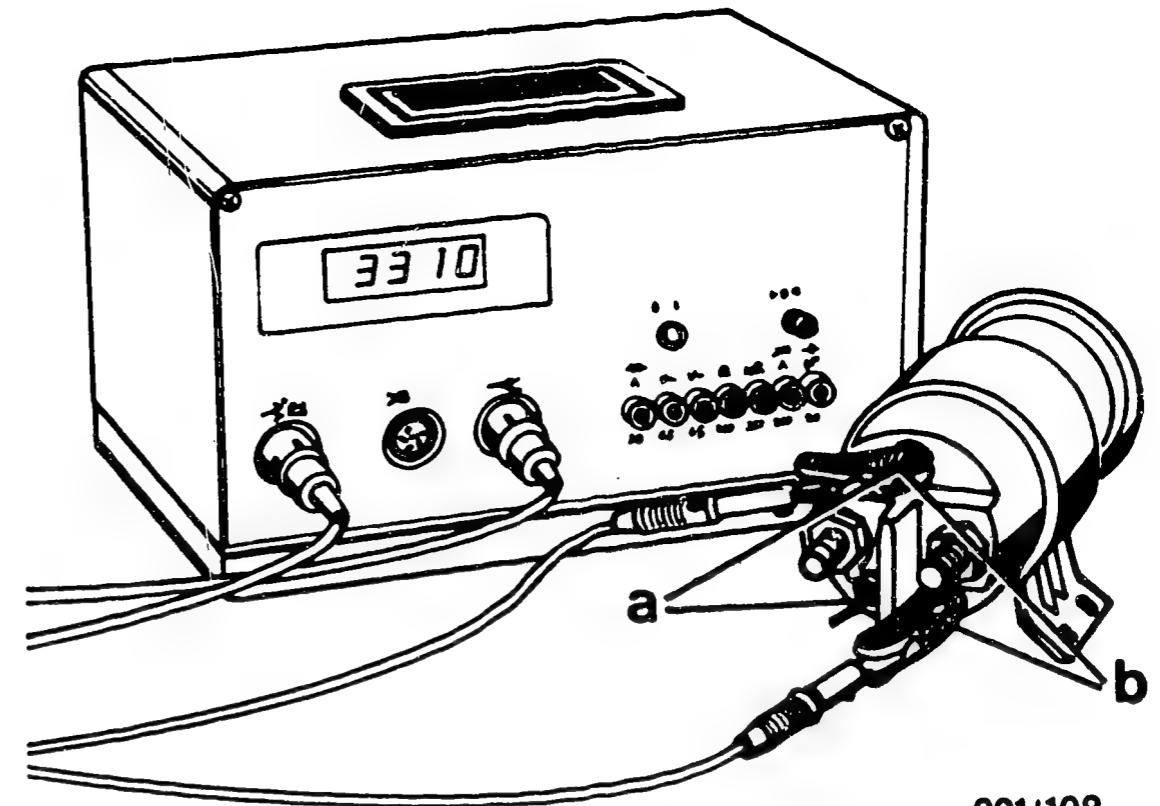
Mark position of pole shoes. Place stator frame in clamping support. Remove nut from bolt of excitation winding (arrow) and pole screws. Remove windings together with pole shoes from stator frame.



001/108-1

Install excitation winding

Heat up excitation winding slightly and insert with pole shoes into stator frame (pay attention to mark).
 Screw on excitation winding slightly and press in drive-in mandrel KDAL 5044 with mandrel press.
 Place stator frame in clamping support and tighten pole screws.
 Tightening torque 48...64 Nm.
 Fit insulating washers and nut of excitation-winding bolt (arrow).
 Tightening torque 25 Nm.
 Press out drive-in mandrel with mandrel press.
 Test installed winding again for short-circuit to ground and open-circuit.



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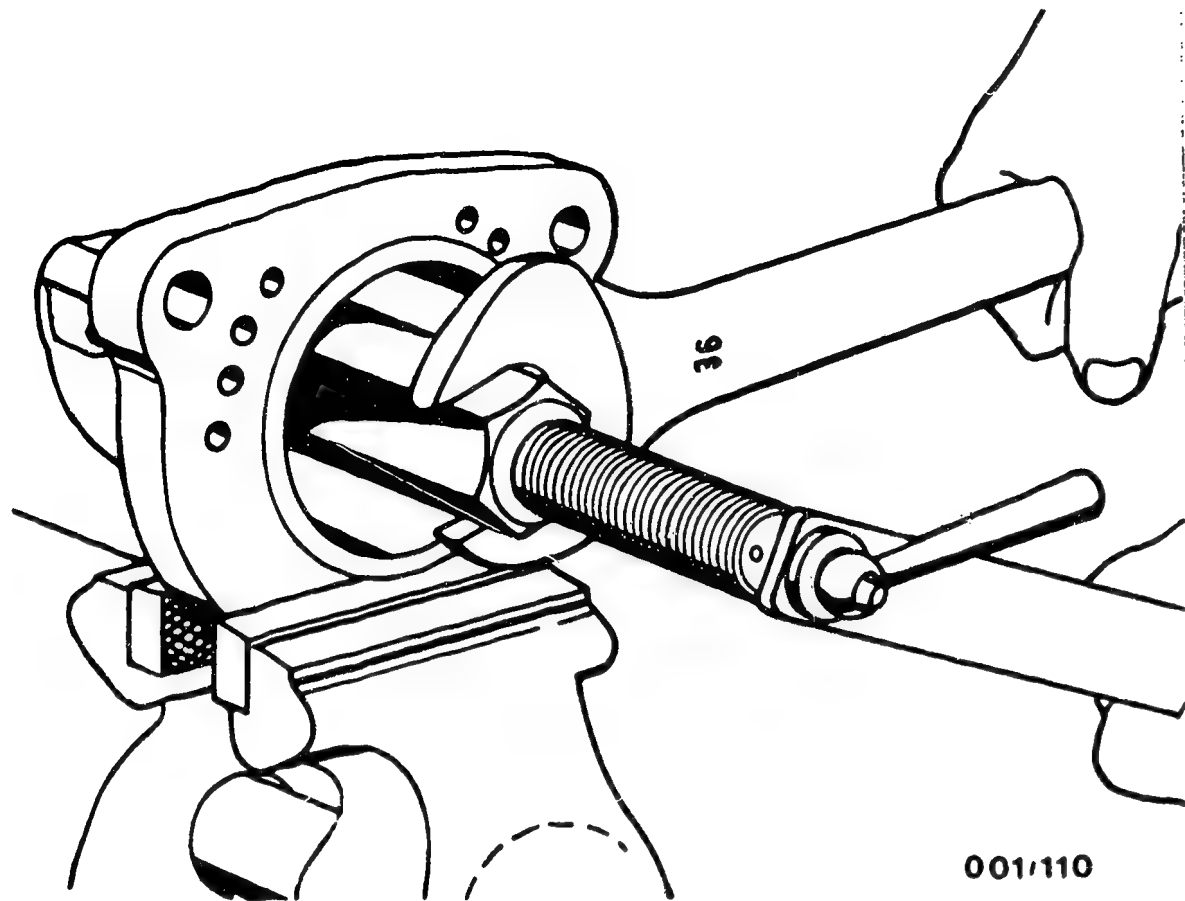
Test solenoid switch

Examine it for damage.

Test resistance of holding winding and pull-in winding (with electric tester ETE 014.00).

	Holding winding	Pull-in winding
24 V:	3,280...3,620 Ω	0,513...0,567 Ω
12 V:	0,712...0,788 Ω	0,152...0,168 Ω

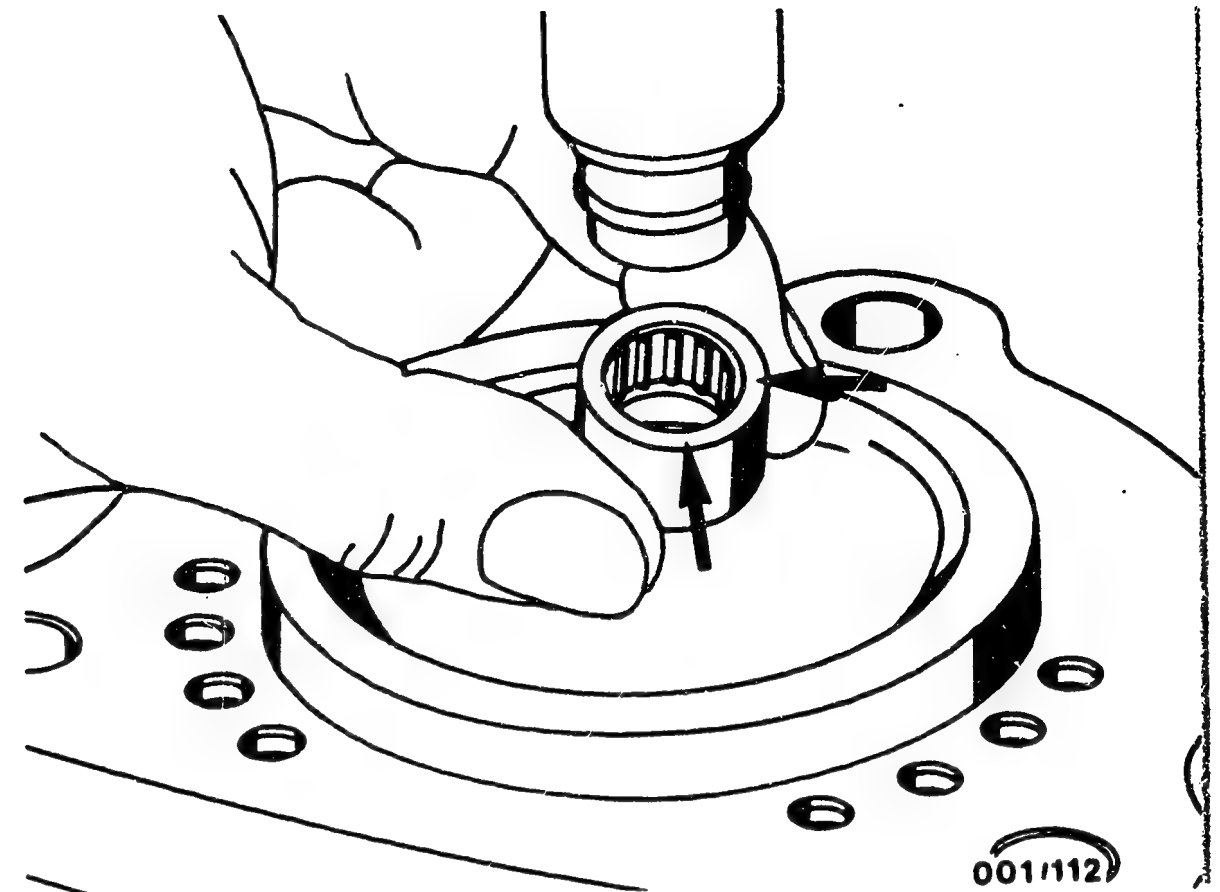
If a functional test is performed, apply voltage to the pull-in winding for a maximum of 4 seconds and to the holding winding for a maximum of 90 seconds.



Remove needle bushing in drive-end-bearing housing.

Use puller KDAL 5492 to extract needle bushing in drive-end-bearing housing (see picture).

Note: Do not renew needle bushing in commutator end shield before testing axial armature play.

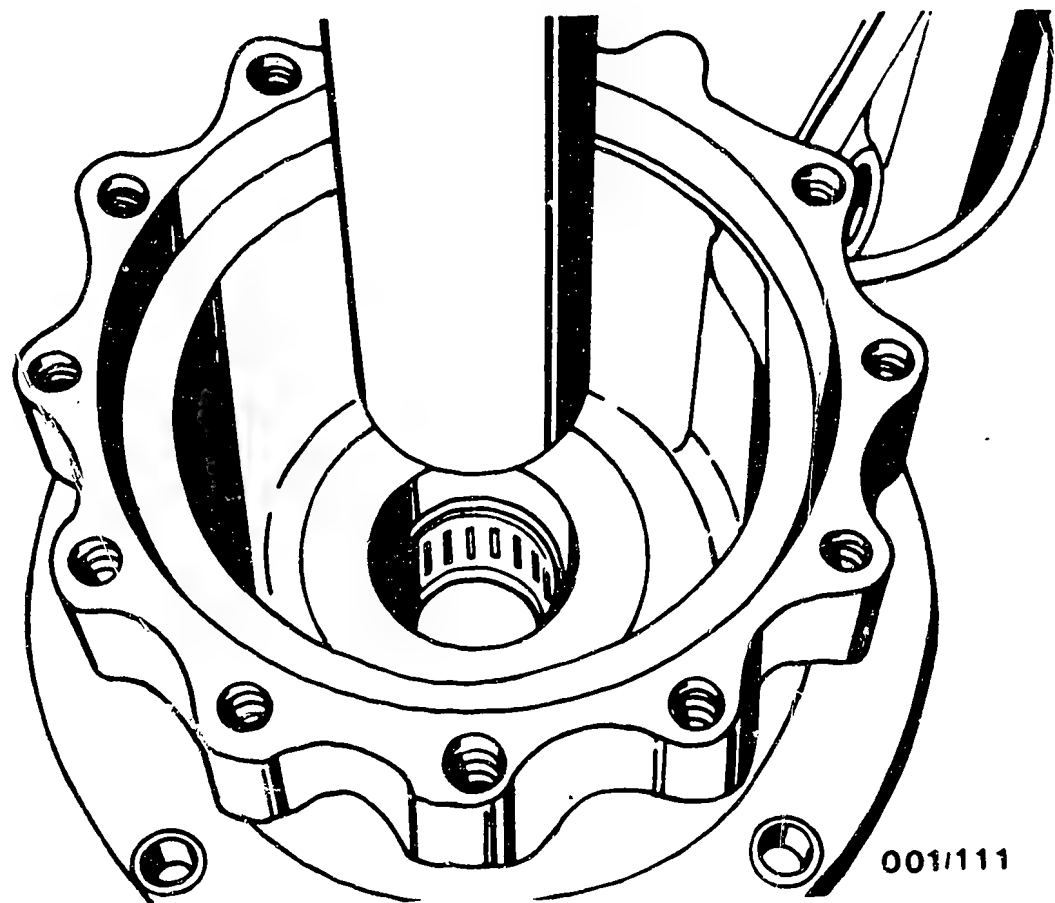


Install needle bushing in drive-end-bearing housing

Examine 2 mm shim (23,8 mm diameter) for damage and renew if necessary.

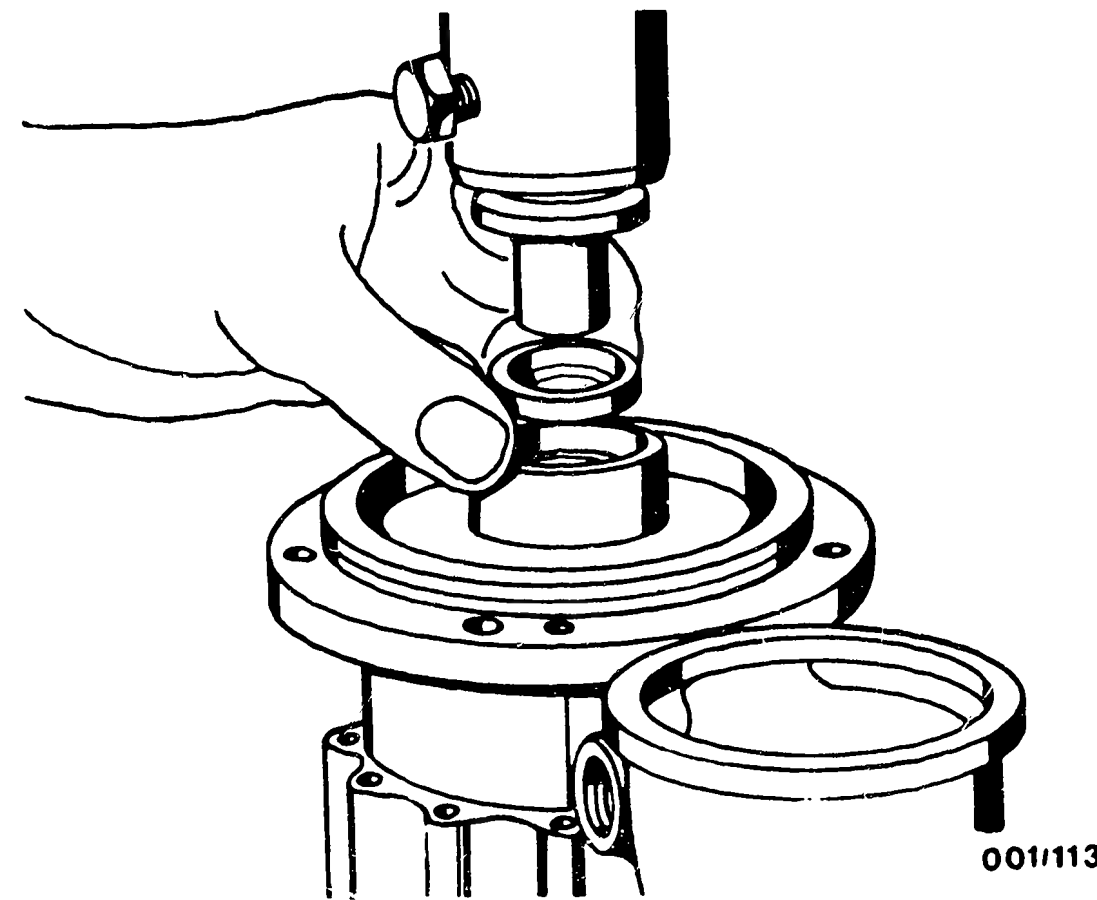
Attach needle bushing to press-in mandrel (KDAL 5039) (labelling on needle bushing must face upwards towards press-in tool, see picture, arrows).

Press needle bushing into drive-end-bearing housing until tool makes contact.



Removing the needle bearing in the intermediate bearing

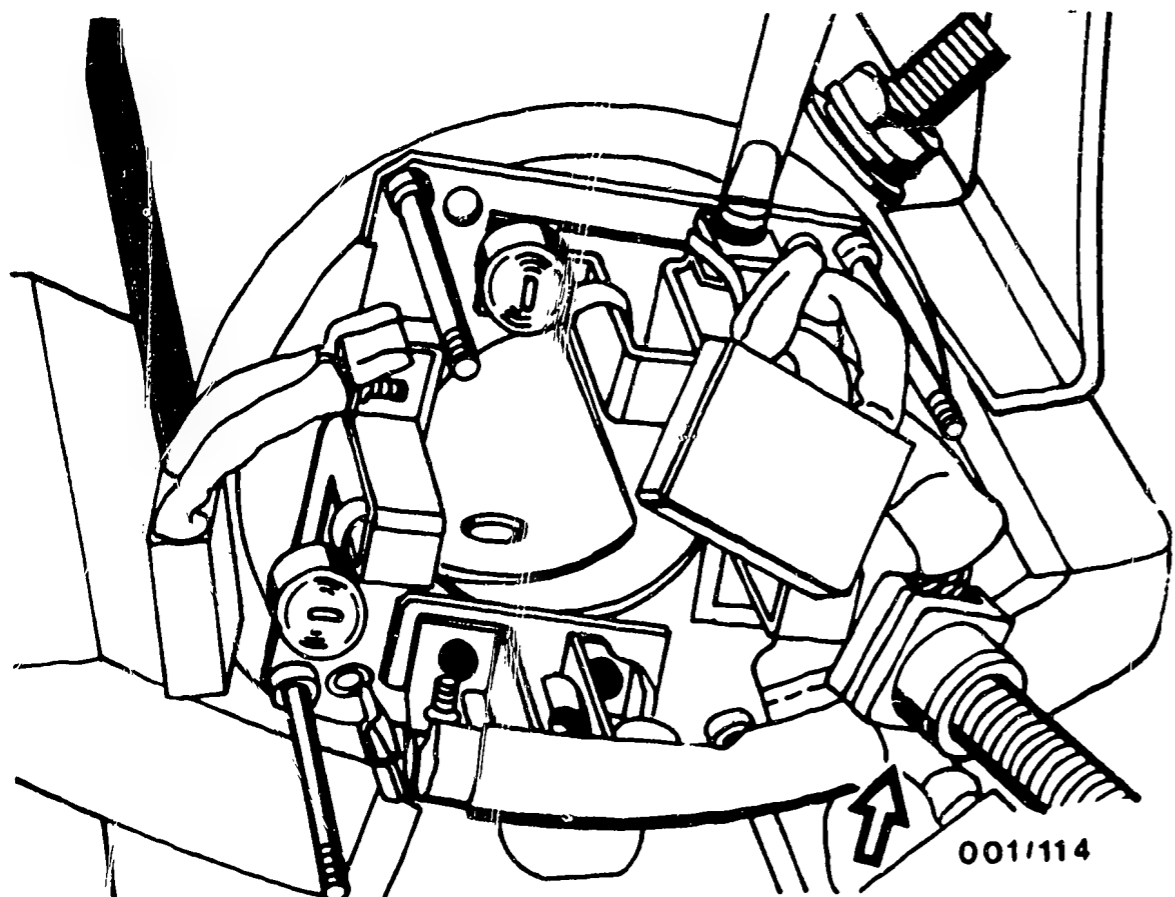
Push the needle bearing and seal ring out of the intermediate-bearing end shield using push-out mandrel (KDAL 5039) (see illustration).



Install needle bushing and seal ring of intermediate bearing

Attach needle bushing to press-in mandrel KDAL 5040 and press it in until tool makes contact with intermediate bearing.

Apply small quantity of special lubricating grease 5 932 240 150 to outside of radial seal and press it in with press-in tool KDAL 5041 until tool makes contact with intermediate bearing. Sealing lip must face needle bushing (see picture).



ASSEMBLING STARTING MOTOR

Attach brush holder

Clamp stator frame in clamping support
KDAL 9999.

Attach brush holder with threaded pin.
Tighten threaded pin with 2 locked nuts.
Tightening torque 4,1...5,5 Nm.

Screw on carbon brushes, excitation winding
and lead.

Ensure proper installation position of lead
with pin term. 31 (see picture, arrow).

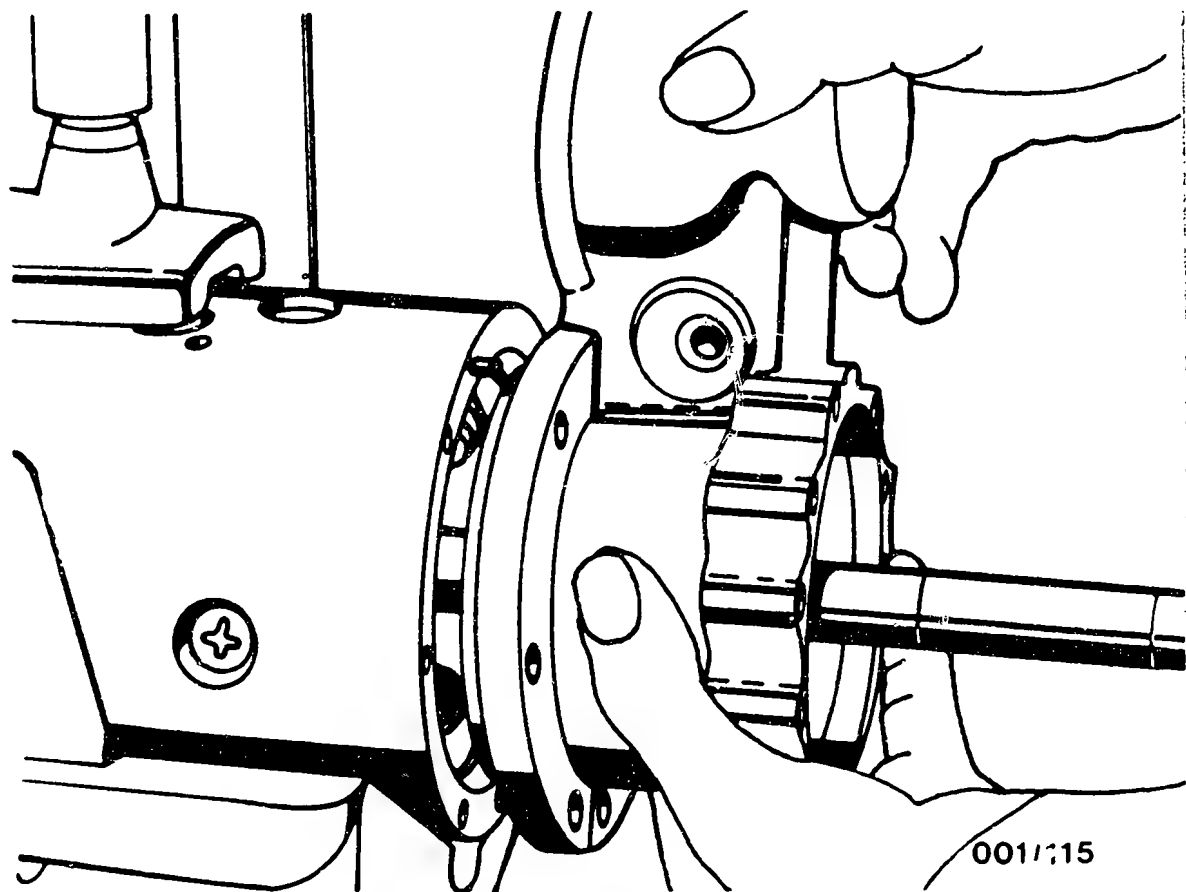
Fit armature

Apply small quantity of special lubricating
grease 5 932 240 150 to wedge and gear contact
surface of armature shaft over entire length.
(Approx. 3 grams).

Completely fill center at both the shaft ends
with special lubricating grease 5 932 240 150.
Slightly lubricate all other bright parts
with anti-corrosion oil 5 701 351 610.

Keep commutator free of oil and grease!

Slide armature from drive-end-bearing housing
side into stator frame.

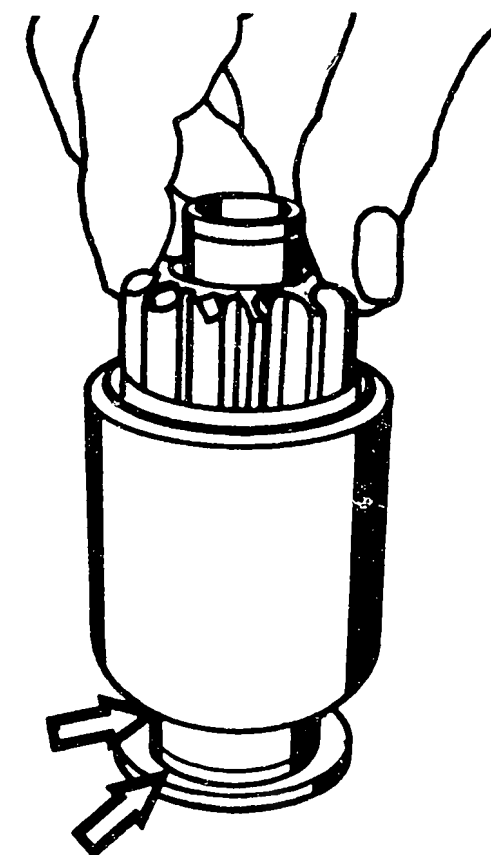


Install intermediate bearing

Apply small quantity of special lubricating grease 5 932 240 150 to O-ring.

Screw on assembled intermediate bearing with new needle-roller bearing, radial seal and O-ring.

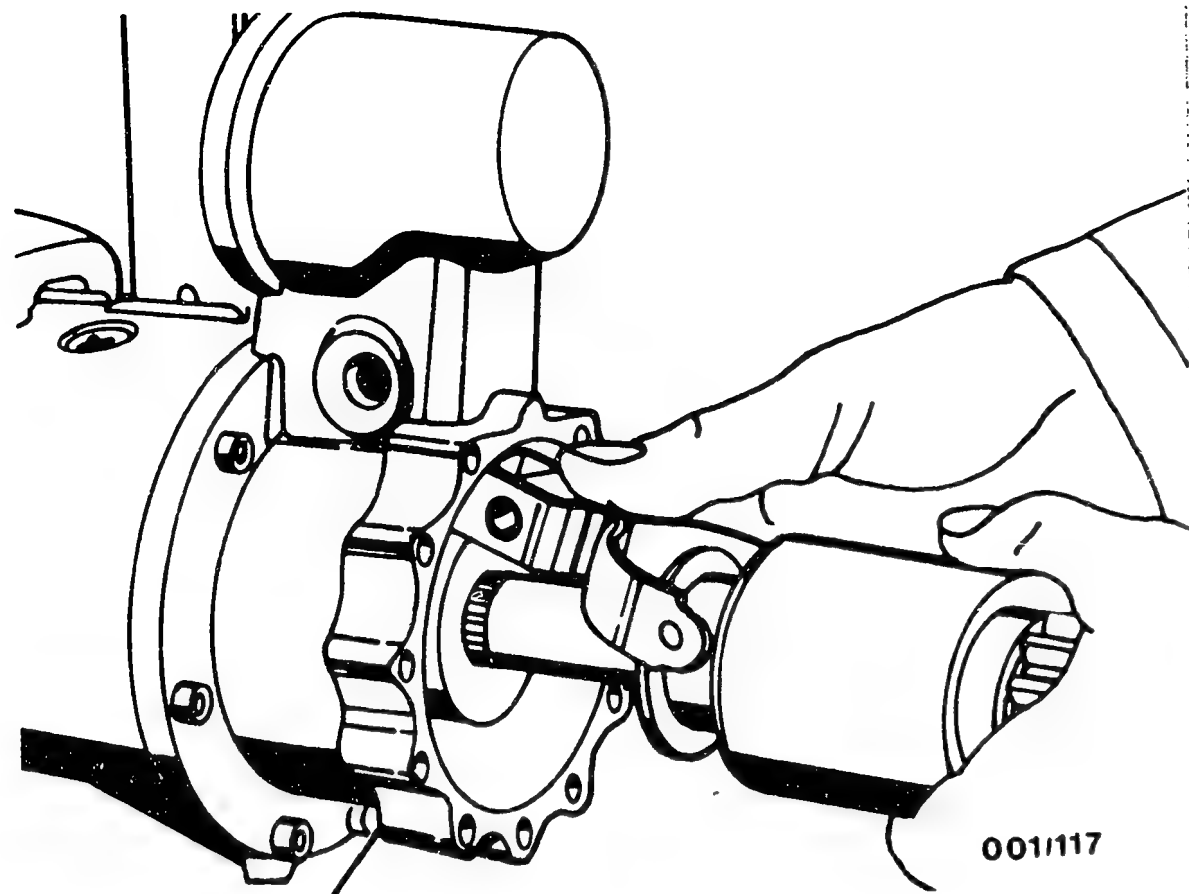
Tightening torque: 10,2...13,6 Nm.



Install overrunning-clutch drive

Examine friction washer (intermediate bearing/plastic) for damage, renew if necessary and slip onto armature shaft.

Apply special lubricating grease 5 932 240 150 on both sides to groove for fork-lever pin at overrunning-clutch drive (see picture, arrows). (0,75 grams in each case).



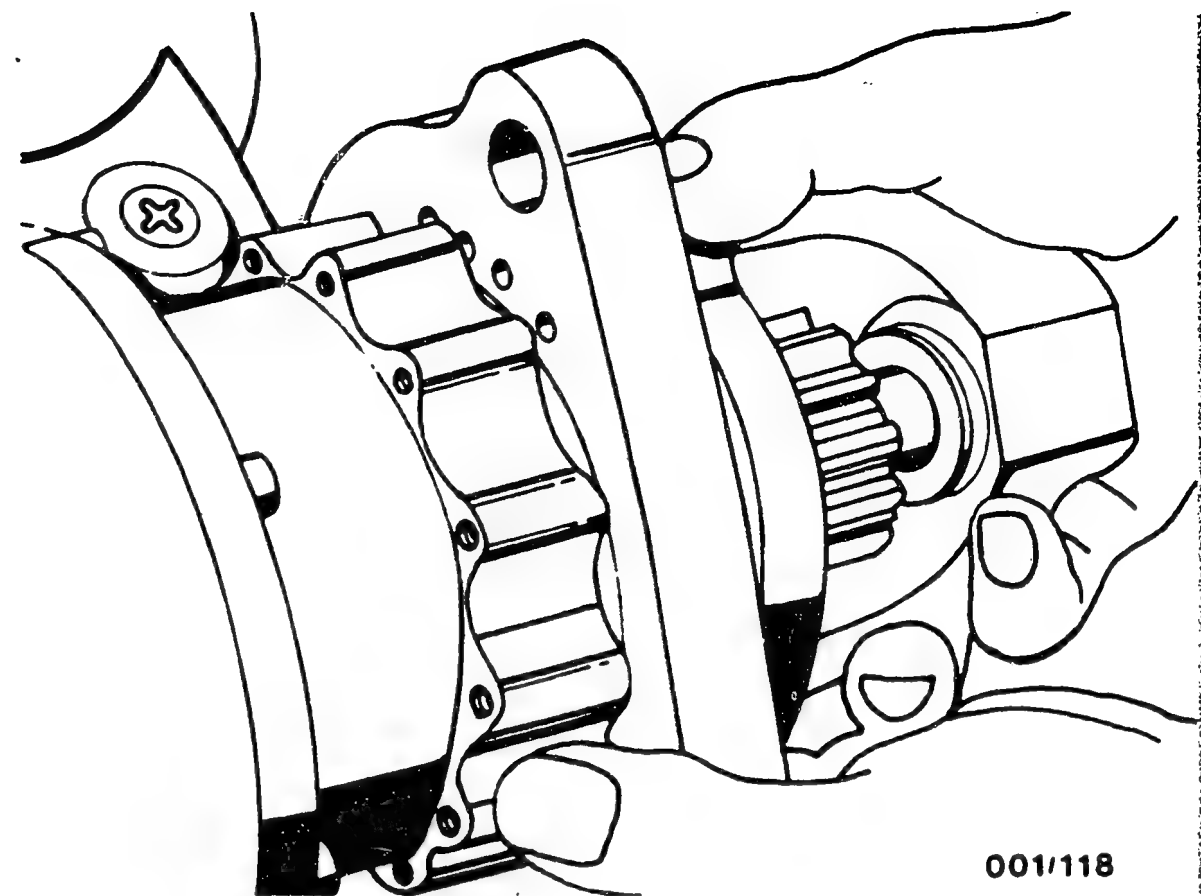
Apply small quantity of special lubricating grease 5 932 240 150 to fork-lever pin.

Slip overrunning-clutch drive together with fork lever on to armature shaft (see picture).

Apply small quantity of special lubricating grease 5 932 240 150 (0,5 grams) to fork-lever mount and install it (use new nut and flat seal ring).

Tightening torque: 12...16 Nm

Slip friction washer (drive-end-bearing housing/steel) on to armature shaft.



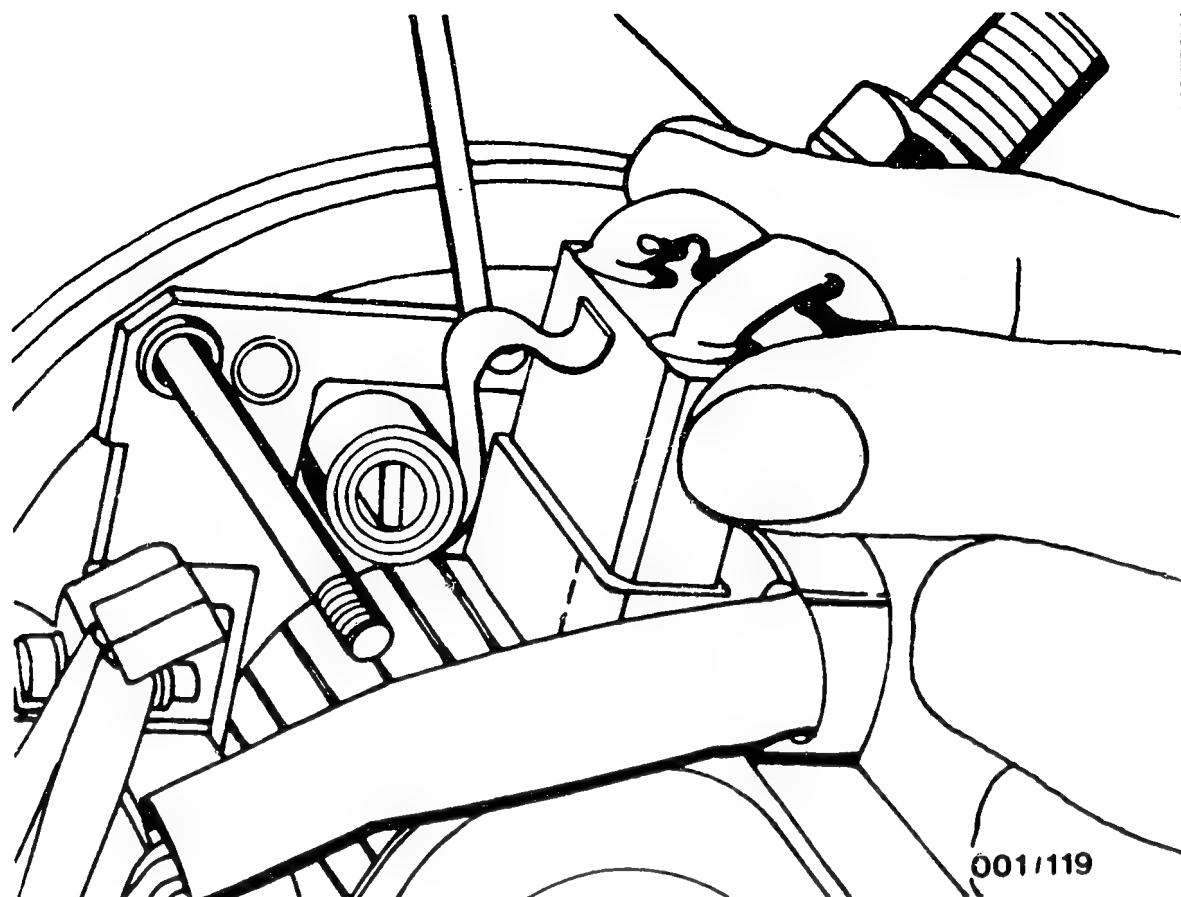
Install drive-end-bearing housing

Apply small quantity of special lubricating grease 5 932 240 150 to O-ring.

Fit assembled drive-end-bearing housing with new O-ring and new needle-roller-bearing bushing to intermediate bearing.

Pay attention to correct position of drive-end-bearing housing/intermediate bearing (mark)!

Tightening torque of hexagon-socket-head cap screws: 10,2...13,6 Nm.

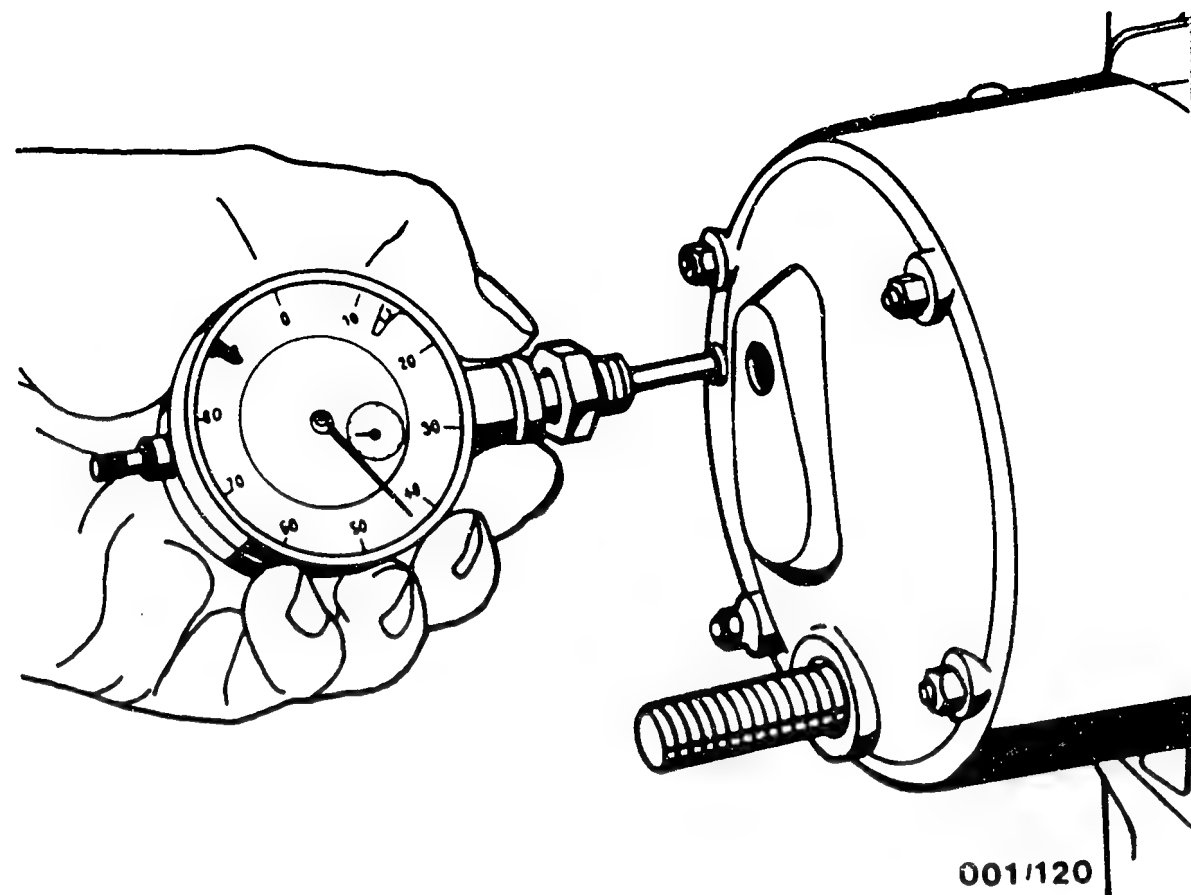


Fit carbon brushes

Lift brush springs with suitable hook and insert carbon brushes.

Minimum carbon-brush length: 17,5 mm

Brush pressure with new carbon brushes 47...53 N

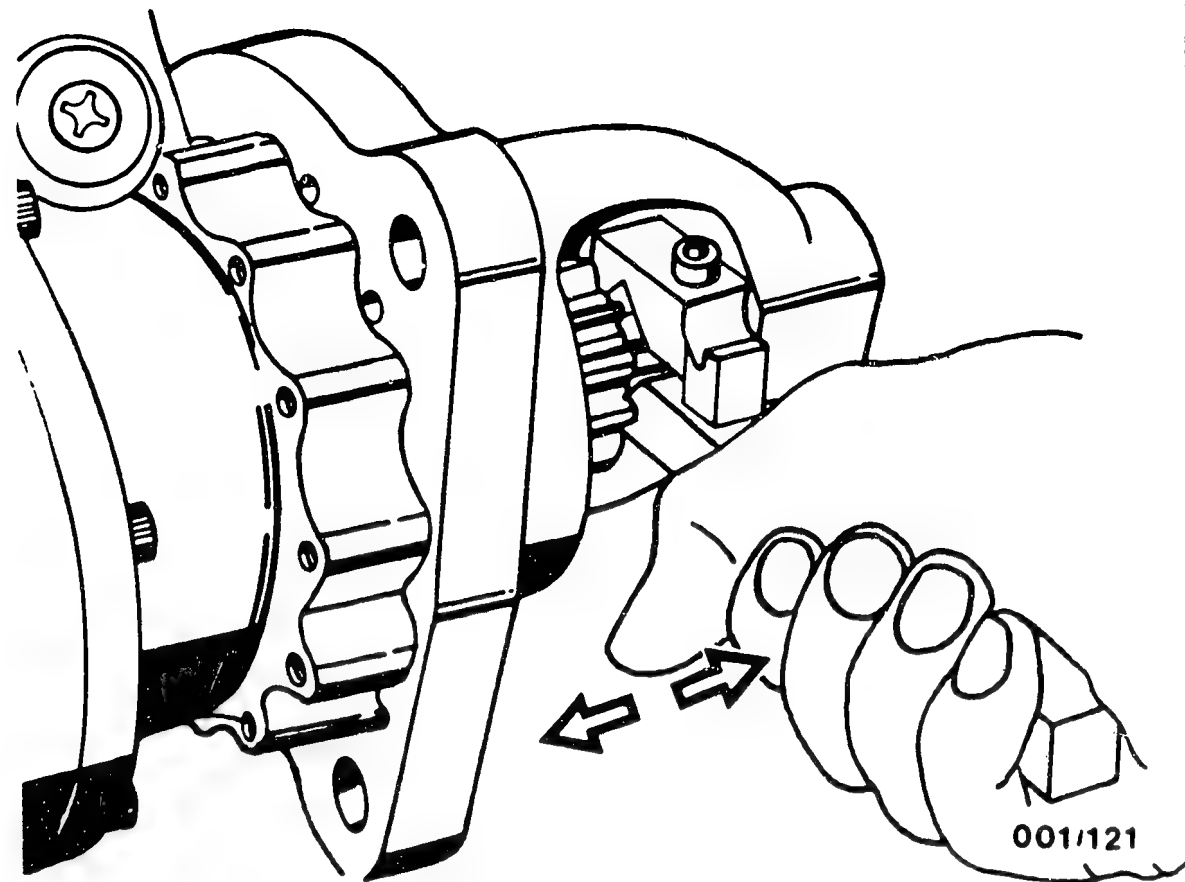


Adjust axial armature play (only commutator end shield with no screw plug, see picture)

Remove O-ring from stator frame (commutator end).

Fit commutator end shield with o 1 d needle bushing (use old nuts). Pay attention to installation position of pin term. 31 (fit plastic guide).

When installing a new commutator end shield without needle bushing, use bushing KDAL 5045 instead of needle bushing to guide armature shaft. Screw dial indicator with measurement insert and measuring tool into thread for test connection of commutator end shield (see picture).



Screw holding tool KDAL 5036 onto armature shaft (drive-end-bearing housing end).

Establish axial armature play at dial indicator by moving armature shaft (do not turn shaft).

Armature shaft must clearly be heard to make contact with shims of drive-end-bearing housing/commutator end shield.

Set value for axial armature play: 0,1...0,4 mm

Remove dial indicator again.
 Unscrew commutator end shield.
 Extract needle bushing with puller KDAL 5492/
 remove bushing KDAL 5045.

If axial armature play is not within tolerance, remove and measure shim (commutator end).

The axial armature play can be adjusted with 4 different shims:

- 2,0 mm
- 2,2 mm
- 2,5 mm
- 2,8 mm

Example of axial armature-play adjustment:

Axial armature-play measured: 0,6 mm
 Old shim: 2,5 mm

Using a 2,8 mm shim reduces the axial armature play to 0,3 mm.

Attach new needle bushing to press-in mandrel KDAL 5039 (labelling on needle bushing must face upwards towards press-in mandrel) and press it in until tool makes contact with commutator end shield.

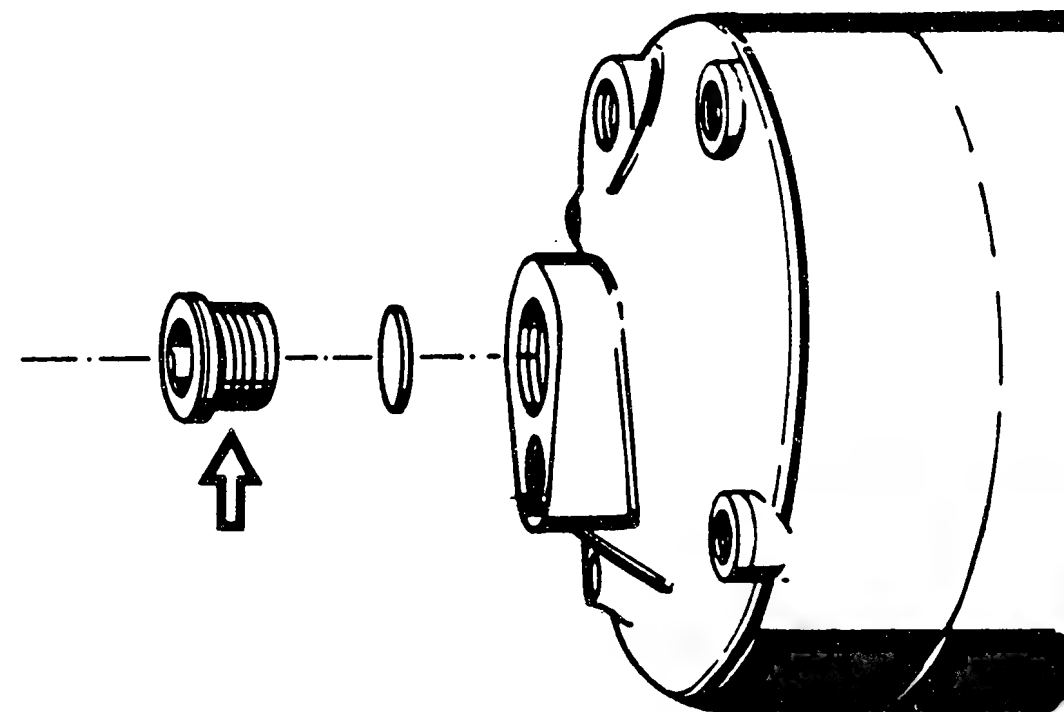
Attach new O-ring to stator frame (commutator end) and pin term. 31 (lead). Apply small quantity of special lubricating grease 5 932 240 150 (pay attention to installation position of term. 31).

Fit commutator end shield (use new seals and new nuts).

Nut tightening torque M 5: 4,1...5,5 Nm

Nut tightening torque M 13: 24... 26 Nm

Re-check axial armature play:
Set value: 0,1...0,4 mm

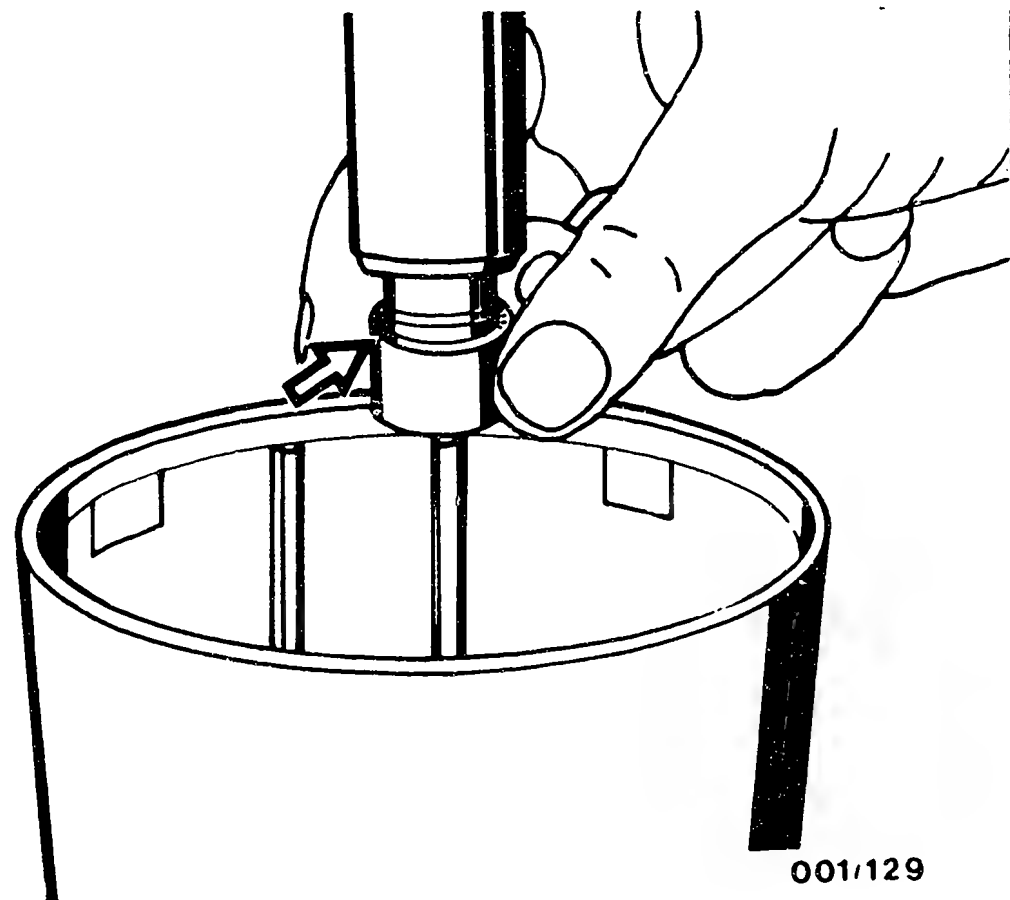


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Adjust axial armature play
(Only commutator end shield with
screw plug , see picture)

With newer starting-motor versions and for replacement purposes, the commutator end shield was provided with an additional hole with screw plug (see picture, arrow). The axial armature play is measured through this hole and adjusted with shims of varying thickness.

Screw off and scrap screw plug (screw plug can only be used once).



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Install new needle bushing before adjusting axial armature play.
Press old needle bushing out of commutator end shield with press-out mandrel KDAL 5038 from outer side.

Attach new needle bushing to press-in mandrel KDAL 5039 (labelling on needle bushing must face upwards towards press-in mandrel) and press it in until tool makes contact with commutator end shield.

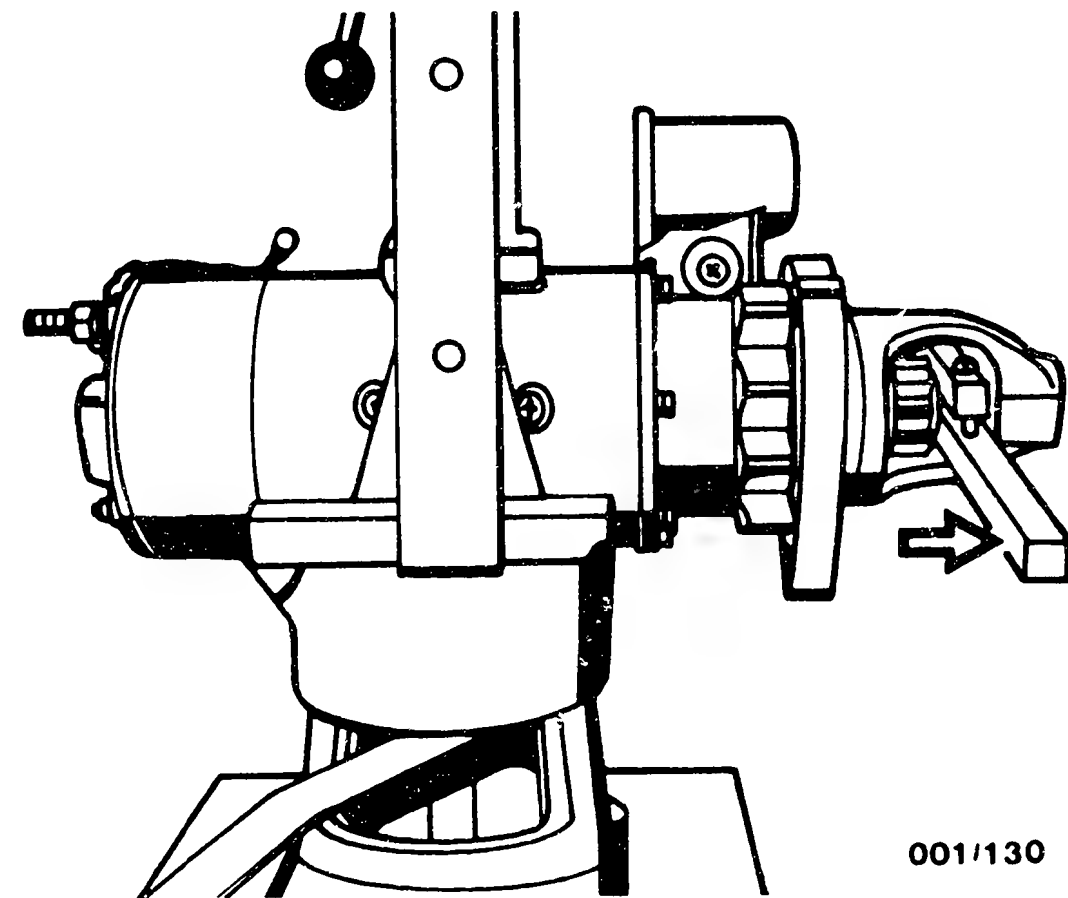
Fit new O-ring on stator frame (commutator end) and pin term. 31 and apply a small quantity of special lubricating grease 5 932 240 150
Fit commutator end shield paying attention to installation position of term. 31 and fit plastic guide.

Use new copper seals and self-locking nuts.

Fit lead (thin, black) term. 31 to solenoid switch.

Nut tightening torque M 5: 4,1...5,5 Nm

Nut tightening torque M 13: 24... 26 Nm

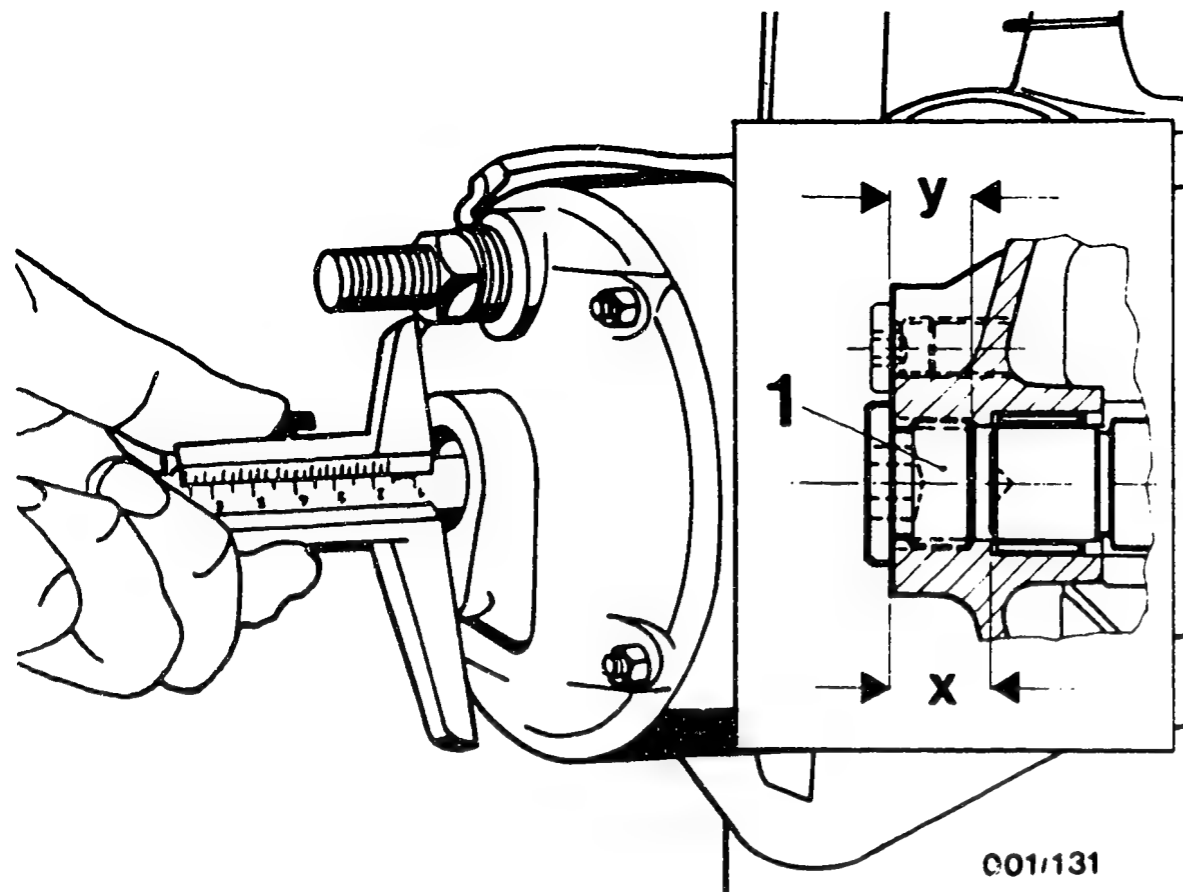


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Screw holding tool KDAL 5036 to armature shaft (drive-end-bearing housing end) (see picture).

Move armature to stop (drive end) (picture, arrow).

Armature shaft must clearly be heard to make contact with shim in drive-end-bearing housing.



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Use caliper gauge or depth gauge to determine extent to which end face of commutator end shield protrudes beyond armature shaft = dimension X. **IMPORTANT:** Do not measure in the center of armature shaft!

Determine screw-in length of screw plug (1) = dimension Y.

The axial armature play results from the difference between dimensions X and Y.

The axial armature play can be adjusted with 6 different shims:

1,5 mm	2,1 mm
1,7 mm	2,3 mm
1,9 mm	2,5 mm

Set value for axial armature play: 0,1...0,3 mm

Example of adjustment of axial armature play:

Extent to which end face of commutator end shield protrudes beyond armature shaft X = 16,05 mm
 Screw-in length Y of screw plug = 13,95 mm

Length difference	2,1 mm
Shim	1,9 mm

Axial armature play	0,2 mm
---------------------	--------

Fit corresponding shim in opening at commutator end shield.

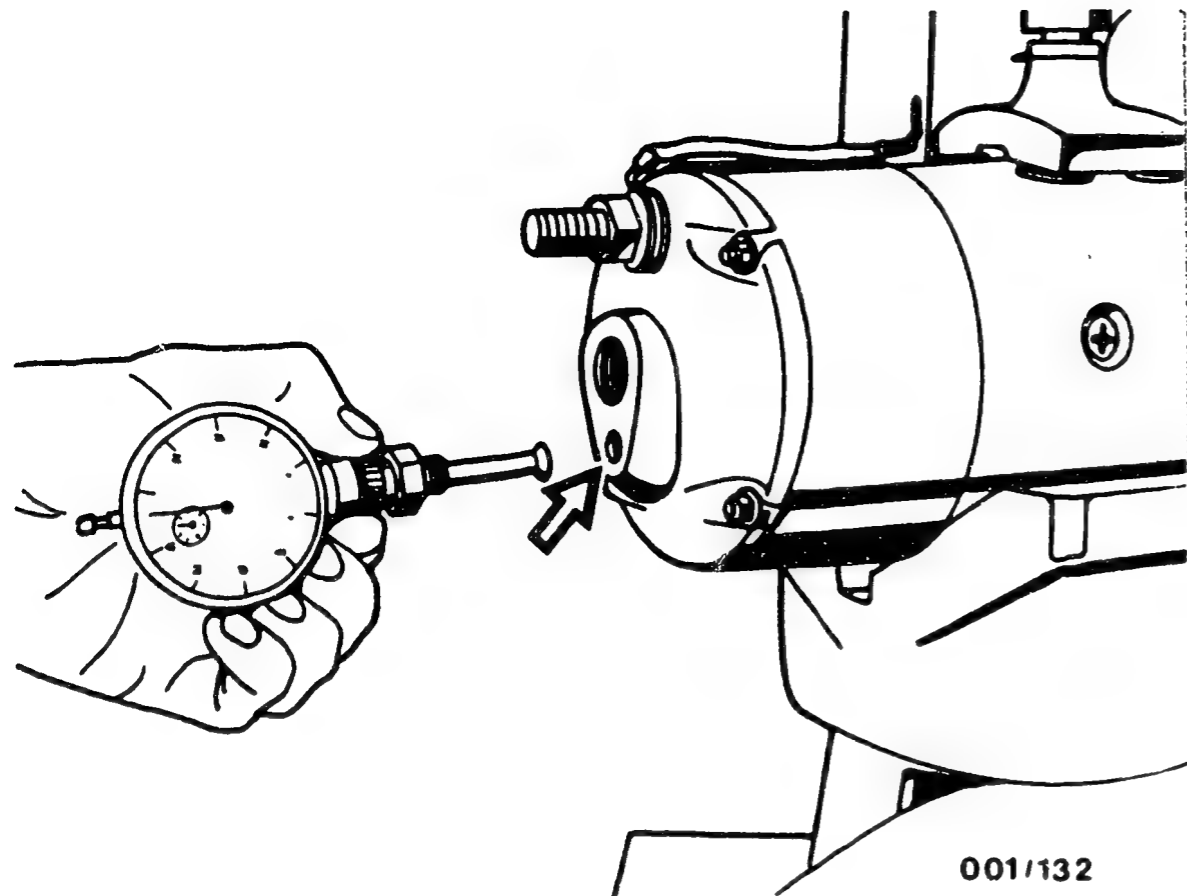
Screw in new micro-encapsulated screw plug and tighten to 45...55 Nm.

Note:

Thread at screw plug and commutator end shield must be grease and oil-free.

Micro-encapsulated screw plug may only be screwed in once

(Micro-encapsulation/locking element is then no longer serviceable).

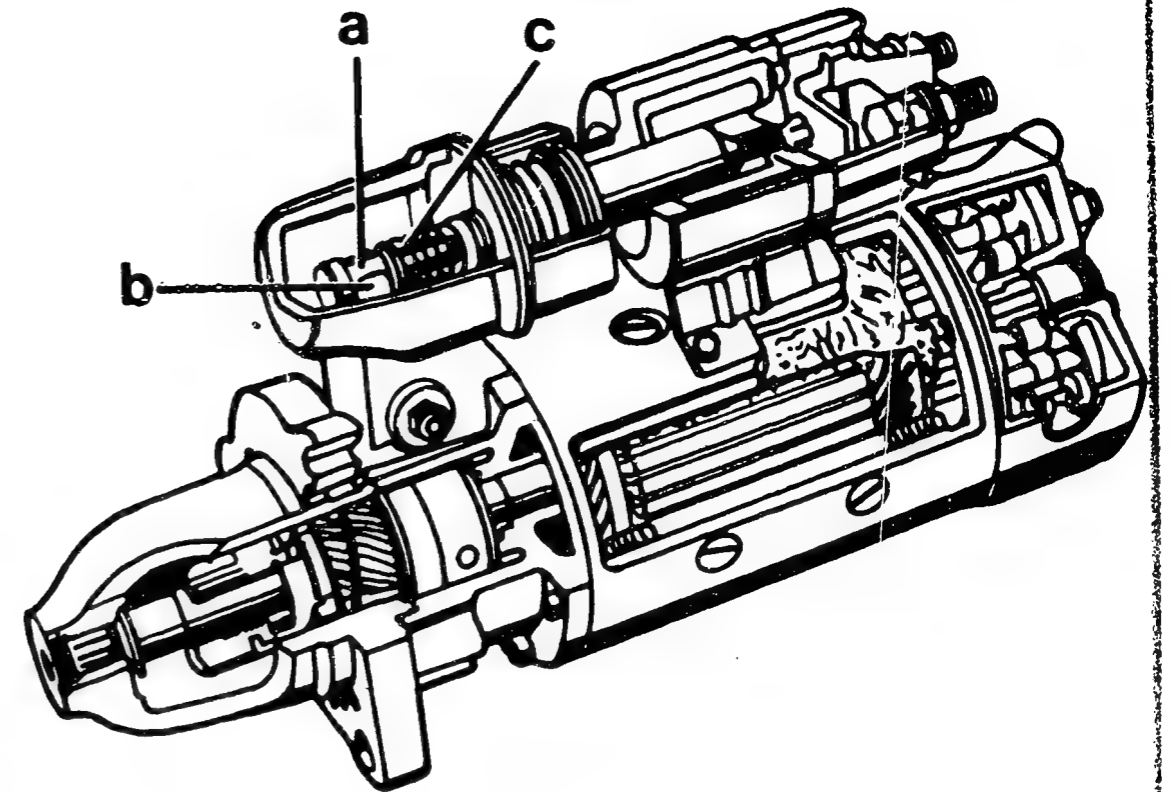


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Test axial armature play

Screw dial indicator with measuring tool KDAL 5037 into thread for test connection at commutator end shield (see picture).
 Move armature shaft in longitudinal direction with holding tool KDAL 5036.
 Armature shaft must clearly be heard to make contact with shims.

Axial armature play should be 0,1...0,3 mm.
 (Read off axial armature play on dial indicator).
 If axial armature play is not within tolerance, repeat above-described adjustment of axial armature play.
 Remove dial indicator with measuring tool and holding tool again.



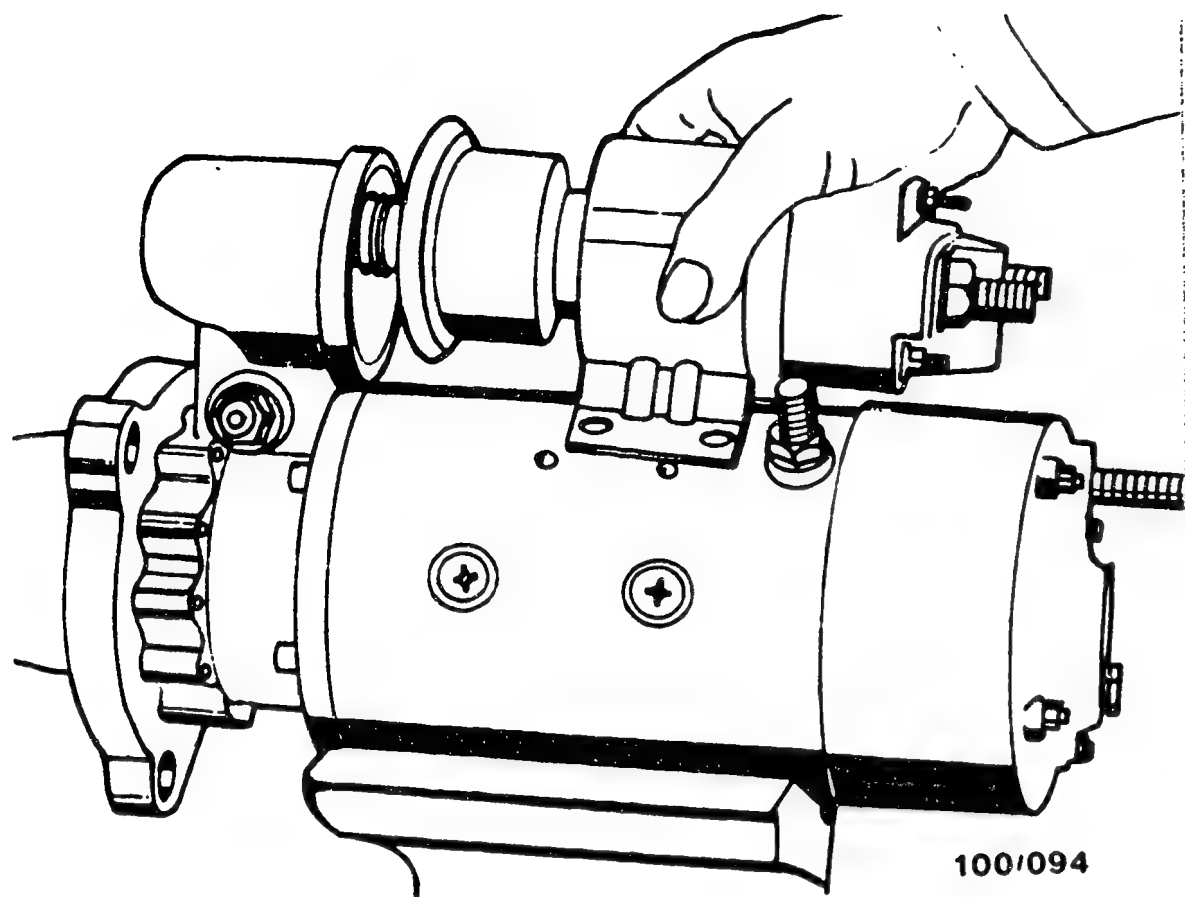
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- a = Thread reel
- b = Fork lever
- c = Armature shaft

Fit solenoid switch

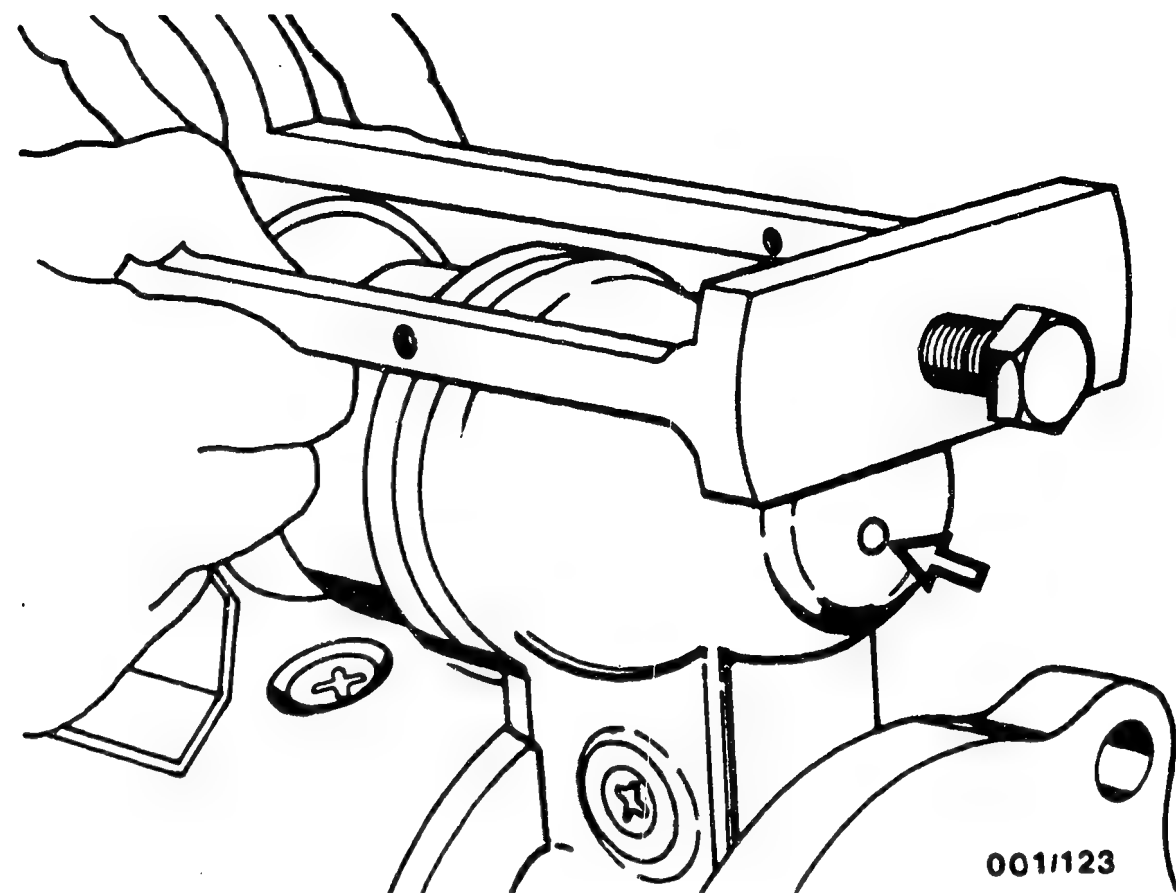
Apply small quantity of special lubricating grease 5 932 240 150 (0,5 grams) to thread reel (a).

Apply small quantity of anti-corrosion oil 5 701 351 610 (0,2 grams) to armature shaft (c).
 Make use of new seal.



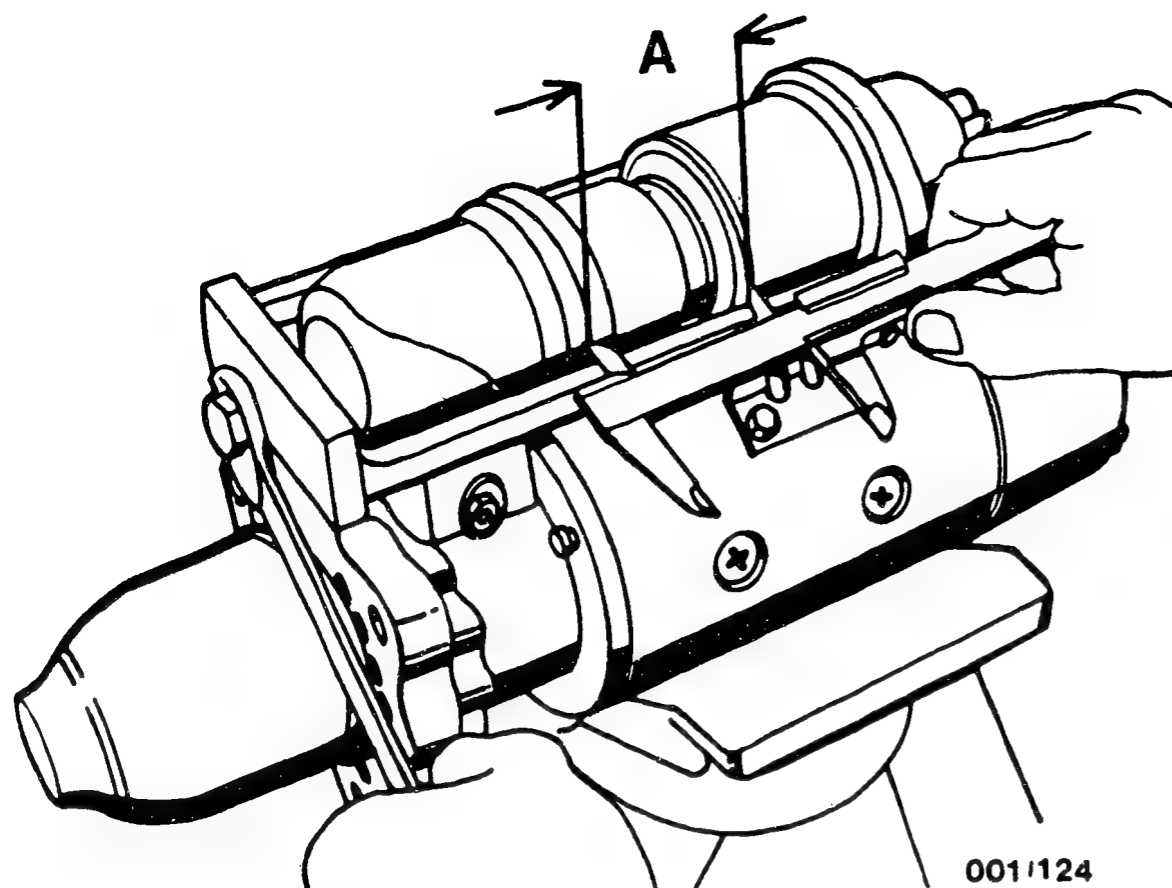
100/094

Suspend solenoid switch in position at fork lever from above (see picture) and attach with four new micro-encapsulated screws in such a manner that the plain washers can still move.



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Fit clamping fixture KDAL 5042 in position and tension slightly. The point of the tensioning screw must be in the centering recess of the solenoid-switch dome (arrow).



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Use clamping fixture KDEL 5054 to set spacing A (mounting bracket - solenoid switch/solenoid-switch dome) to $62,5 + 0,2 - 0,5$.

Tighten fastening screws of solenoid switch to 7,2...9,7 Nm.

Remove clamping fixture.

Fit bus bar.

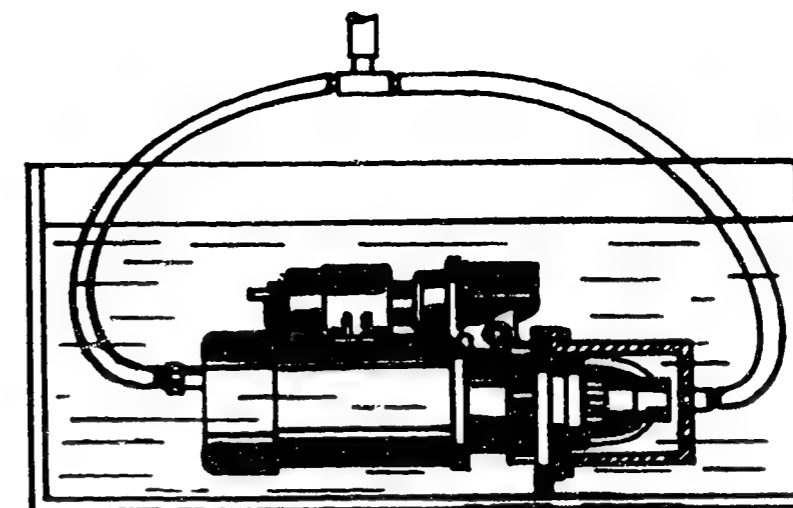
Tightening torque of two nuts: 24...26 Nm

Fit lead term. 31.

Tightening torque:

term. 31 solenoid switch: 4... 5 Nm

term. 31 commutator end shield: 24...26 Nm



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Leak test (waterproof version)

Unscrew plug at commutator end shield. Screw test connection (KDAL 5043/2) with flat seal ring and compressed-air line into commutator end shield.

Seal starting motor on drive-end-bearing housing end with cap (KDAL 5043).

Attach compressed-air lines to "T-piece" and connect.

Test pressure: 0,2 bar

Test duration: 30 seconds

The starting motor must be completely underwater (see picture).

There must be no air bubbles.

After testing, re-seal opening at commutator end shield with plug and seal.

Tightening torque: 16...20 Nm.

TESTING ON THE TEST BENCH

General

The following test benches may be used:

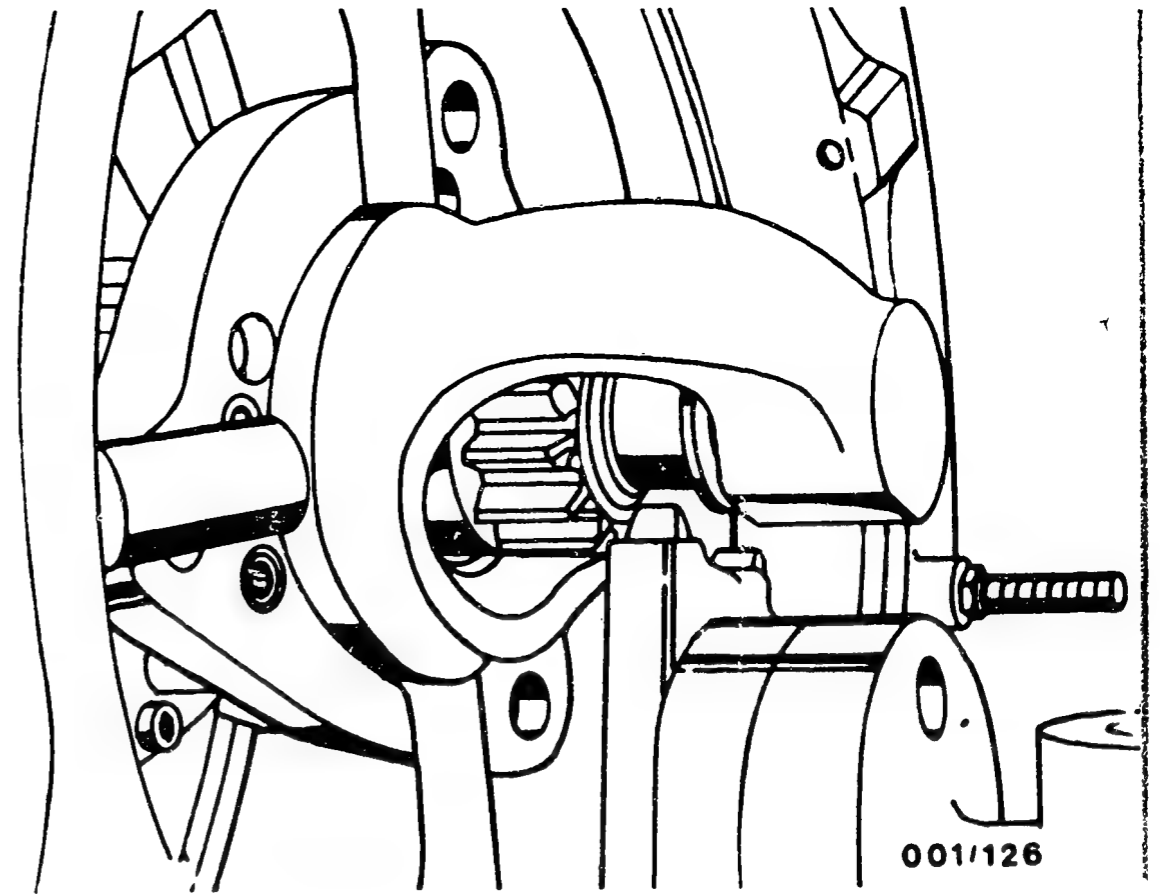
EFAL 140 in connection with a clamping flange for 12 V and 24 V starting motors.

EFAL 152 These test benches cannot be used
EFAL 153 to test 12 V starting motors at full power (resistance of leads and relays of test bench would have too much of an effect).
The short-circuit test specifications indicated here already take account of these losses caused by the test bench.

Clamp the starting motor properly in position on the test bench.
Connect the positive and negative cables of the test bench to the starting motor. Properly tighten the electrical connections (connecting pins).

The electrical test specifications depend on the condition of the battery (capacity and state of charge) and the duration of the test (heating up of the starting motor, discharging of the battery). The test specifications apply only to the test bench and cannot be used for starting motors installed on the engine/in the vehicle. A small starting motor is more heavily loaded by the battery installed in the test bench, whereas, with the largest types of starting motor, the capacity of the test bench battery is not sufficient to obtain the maximum power. The longer leads which are inevitable in the test bench also influence the power of the starting motor. Therefore, the duration of the test should be as short as possible and the batteries should be properly charged, at least three quarters charged.

In the case of defective starting motors, the measured values differ considerably from the stated test specifications. In this case, disassemble the starting motor once again and repeat the tests on the individual parts.



Minimum pull-in voltage for solenoid switch (installed on starting motor)

Produce tooth on tooth position with minimum spacing between flanged bearing and ring gear.

In the case of the specified voltage values, the bearing sleeve of the overrunning-clutch drive must be pushed at least 10 mm forwards (towards the drive-end-bearing housing).

Minimum voltage with tooth/tooth connection:

24 V solenoid switch: ≥ 16 V
12 V solenoid switch: ≥ 8 V

Idle and short-circuit test

The test specifications are referenced to 3/4-charged 2 x 12 V 143 Ah batteries connected in series in the case of 24 V starting motors and in parallel in the case of 12 V starting motors.

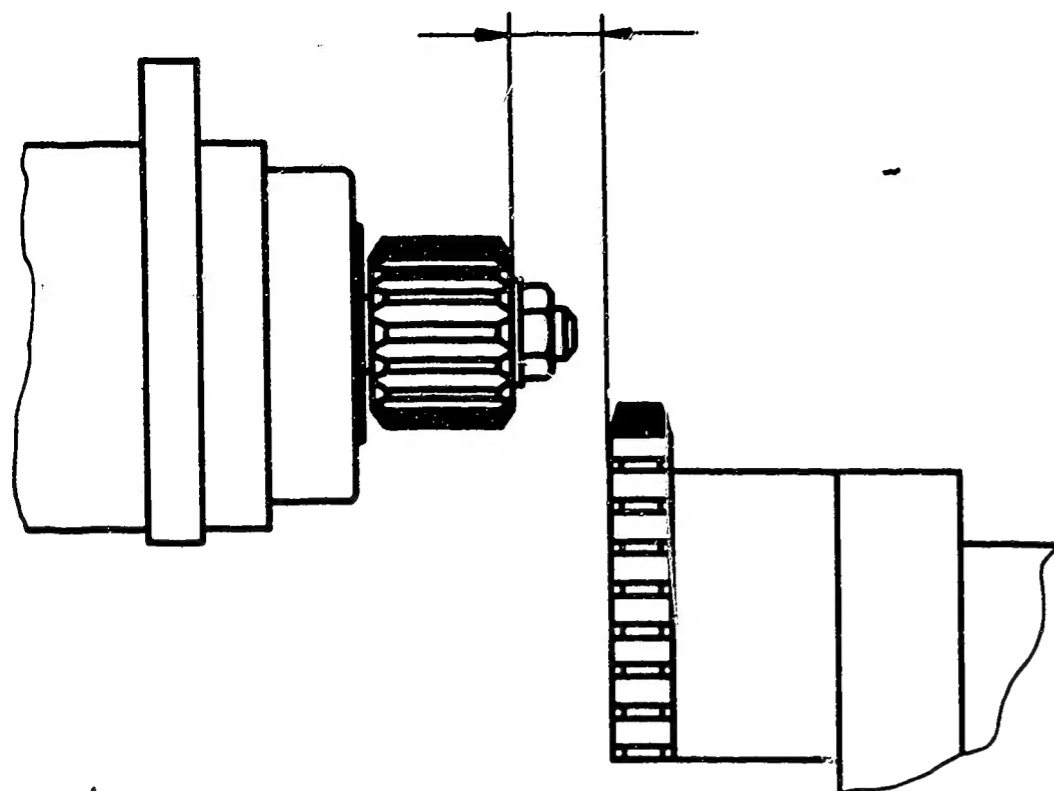
Idle test	V	< A	> min ⁻¹
0 001 420 ...	24	140	5500
0 001 421 ...	11,5	200	5500

Short-circuit test

When performing short-circuit test, ring gear/gear segment of test bench and starting-motor pinion must have the same modulus (teeth characteristics). Otherwise, replace ring gear of test bench or set different gear segment (refer to vehicle-electrics characteristic data for modulus and number of teeth of starting-motor pinion).

Backlash

The backlash is the distance (play) between the tooth flanks of the meshed pinion and those of the ring gear/gear segment. To make the measurement, mesh in the pinion electrically (energize only term.50), and test the backlash using a feeler gauge (not possible if starting motor is installed in vehicle). If the play is too little or too great, this leads to heavy wear on the teeth and can even cause entire teeth to break off.



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Pinion clearance

The pinion clearance is the clearance between the ring gear or gear segment and the end face of the pinion with the starting motor in the rest position. If the clearance is too great, the pinion will not sufficiently mesh with the ring gear; the pinion teeth and the ring gear teeth do not have sufficient contact and are, therefore, heavily loaded on one side. The minimum clearance is necessary so that the pinion reliably demeshes, so that it does not strike against the moving ring gear in the case of heavy vibration and also so that it cannot mesh in so far that the pinion shaft comes up against the ring gear.

Pinion clearance 3.0 ... 4.0 mm.

Test sequence

Set measuring-range selector switch.

In the case of test benches with toothed gear/ring gear, switch on starting motor and bring to a stop.

Read off test specifications.

Only perform test for a brief period.
Max. 1 - 2 seconds.

In the case of test benches with a fixed gear segment, briefly switch on starting motor and read off test specifications.

Short-circuit test specifications are listed in the following table.

Starting motor	V	A	Torque
0 001 420 ...	9	< 1400	> 110
(with 2 batteries 12V 143Ah connected in parallel)			
0 001 421 ...	4,0	< 1900	> 75
	4,5	< 2050	> 90
(with 2 batteries 12V 143Ah connected in series)			

HEALTH HAZARD DUE TO
ASBESTOS DUST

VDT-I-Gen. 043 En
12.1981
supercedes edition 11.1981

Note on repair
Extractor for undercutting (commutator) saw

Working on asbestos or products containing
asbestos results in the generation of dust
and minute fibers which can in the long term
lead to serious damage to health.

The European Community passed a law on
March 28, 1981 restricting the use of
asbestos and providing for new safety
regulations with regard to working with
materials containing asbestos.

NOTE ON THE REPAIR OF STARTING MOTORS,
GENERATORS AND MOTORS

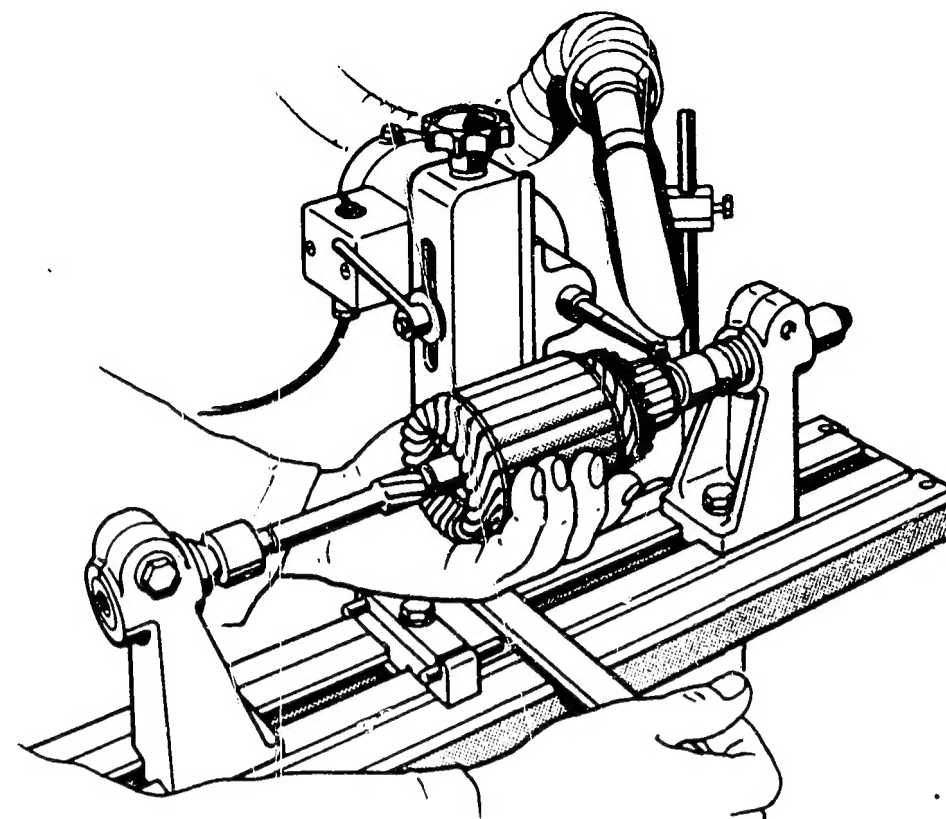
The insulation between the commutator
segments of the armatures of starting motors,
generators and motors still has a high asbestos
content.

IT IS ABSOLUTELY ESSENTIAL TO EXTRACT THE
ASBESTOS DUST GENERATED WHEN UNDERCUTTING THIS
INSULATION WITH UNDERCUTTING SAW KDAW 9998!

As laid down in the new VDI guidelines, the
asbestos dust must only be extracted with an
APPROVED DIRT EXTRACTOR.

We therefore recommend the dirt extractor
WAP-turbo-M-1 S-FA with the seal of approval of the
German Employers' Liability Insurance Association,
obtainable from

Firma Guido Oberdorfer
WAP-Maschinen
D-7912 Bellenberg
Tel. 07306/5055



As an accessory for the extractor, we offer
the stand KDAW 9998/20 which can be used for
securing the suction tube with nozzle (see
illustration).

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Training and Technology (KH/VSK)

Please direct questions and comments
concerning the contents to our authorized
representative in your country.

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For production reasons:
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